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ATIKOKAN GS PREOPERATIONAL AQUATIC SURVEY YEAR II, 1982-1983

Report No 84-54-K

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ABSTRACT

The second year of preoperational aquatic studies at Atikokan GS was conducted from April 1982 to February 1983. Many aspects were similar to findings in the first year of study. Oxygen depletion in the summer and during February was apparent in all of the basins studied. The lakes in the study area had low alkalinity and moderate levels of nutrients and ions. Most chemical parameters were highest in Icy Lake and lowest in Slush Lake. Mercury levels in northern pike from Slush Lake were above the MOE guideline. Aquatic vegetation was generally distributed in a zonal pattern associated with changes in water depth. Blacknose shiner and mimic shiner were the most commonly caught fish in beach seines while white sucker and cisco were most commonly caught in gill nets. The major differences between the first and second years of study were an apparent increase in mean pH which may have been an artifact of sampling schedule and in the composition of the fish catch due mainly to a change from trap nets to gill nets. No spawning walleye were observed at the outflows of Icy or Abie Lakes where spawning had been previously observed.

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To Dr. W.R. Effer
Manager
Environmental Studies and
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Design and Development Division

ATIKOKAN GS PREOPERATIONAL AQUATIC SURVEY
YEAR II, 1982-1983

1.0 INTRODUCTION

Atikokan GS, currently under construction, will consist of one 200 MW lignite-fired unit. The condenser cooling water for Atikokan GS will be drawn from approximately the 10 m depth in Moose Lake and discharged on the surface into Snow Lake. The discharge water will circulate through Icy, Abie and Marmion Lakes before returning to Moose Lake (see Figure 1).

At new Ontario Hydro generating stations, three years of biological surveys are conducted prior to commissioning of the first unit. The purpose of these three years of study as requested by Environmental Studies and Assessments Department, Design and Development Division is to establish a baseline description of the physical-chemical and biotic features of the aquatic environment in sufficient detail to document significant changes in those features during similar studies conducted during the operation of the station. This report presents the results of the second year of study. The second year of study was less intensive than the first (Ontario Hydro Research Division Report No 83-338-K) with sampling conducted in May, August and October 1982 and February 1983.

Study Area

The study area consists of the five lakes of the cooling circuit; Snow, Icy, Abie, Marmion and Moose, along with two control lakes, Lower Seine Bay, on Marmion Lake and Slush Lake.

Ten locations were chosen for study in 1982; one each in Snow, Icy, Abie, Slush and Moose Lakes, and Lower Seine Bay and four in Marmion Lake (Figure 1). Those being, one in the basin north

FIGURE 1

COOLING WATER CIRCUIT ATIKOKAN GS

163889 RD

of Anderson Dam, one at the outlet of Abie Lake, one at the West Dam (Marmion North), and the last in the central section of the lake. Seven of these locations (Snow, Icy, Slush and Abie Lakes, Marmion South, North and Anderson Dam) were selected for intensive study. Only fishing was conducted at the remaining three locations.

Due to construction considerations the water level in Moose Lake was approximately 13 m below normal levels at the beginning of sampling and was raised gradually during the year. Water levels in Snow and Icy Lakes were also lowered during 1982.

Historical Perspective

Before the twentieth century the study area was part of the Seine River Valley, as it flowed from Lac des Mille Lac into Sawbill Bay, through Moose Lake, Steep Rock Lake and finally into Rainy Lake (Ontario Hydro Report No 75177).

In the late 1920's, the Minnesota Ontario Pulp and Paper Company built eight dams on the Seine River in the area of Moose Lake to provide head for a hydro-electric plant at Steep Rock Falls. With the discovery of iron ore under Steep Rock Lake and its subsequent exploitation by the Steep Rock and Caland iron mines, further work was completed that resulted in the diversion of the flow of the Seine River west, through Clearwater Lake (now Finlayson Lake) into the western arm of Steep Rock Lake. This resulted in the partial or complete isolation of Marmion, Moose, and the central and eastern arms of Steep Rock Lake from the Seine River and the flooding of a large portion of land which is now part of Marmion Lake.

To allow work upon the ore body, the central and eastern arms of Steep Rock Lake were dewatered. The lake bottom sediments were then dredged off and deposited in the Upper and Lower Basins of Moose Lake, and the southern portion of Marmion Lake.

By 1981, both mines had been closed for several years and the large pits were being allowed to refill naturally.

2.0 METHODS

The sampling locations utilized in 1982 are presented in Figures 2 to 7 and the sampling schedule is presented in Table 1.

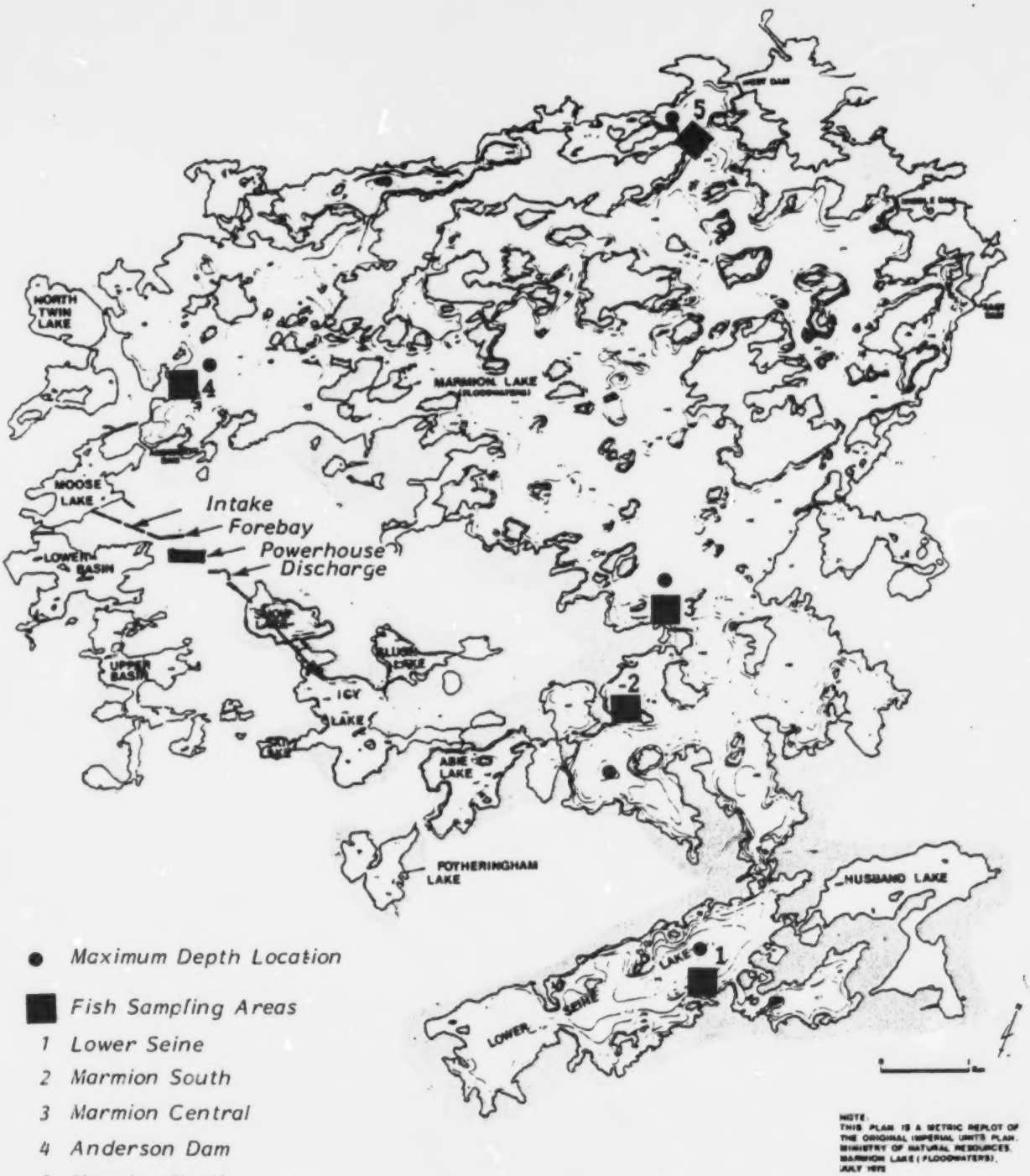

FIGURE 2

SAMPLING LOCATIONS MARMION LAKE - YEAR II

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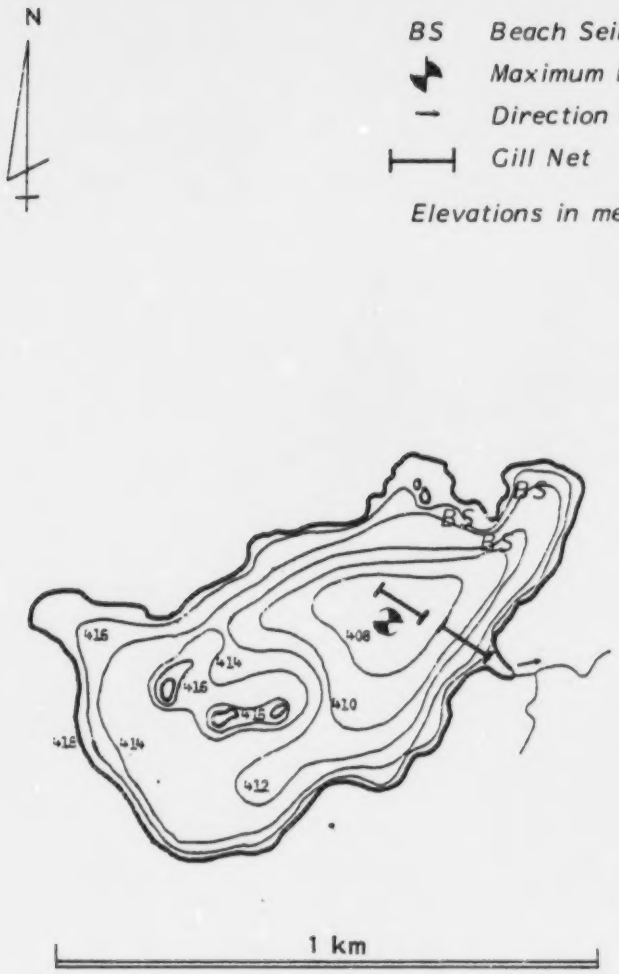
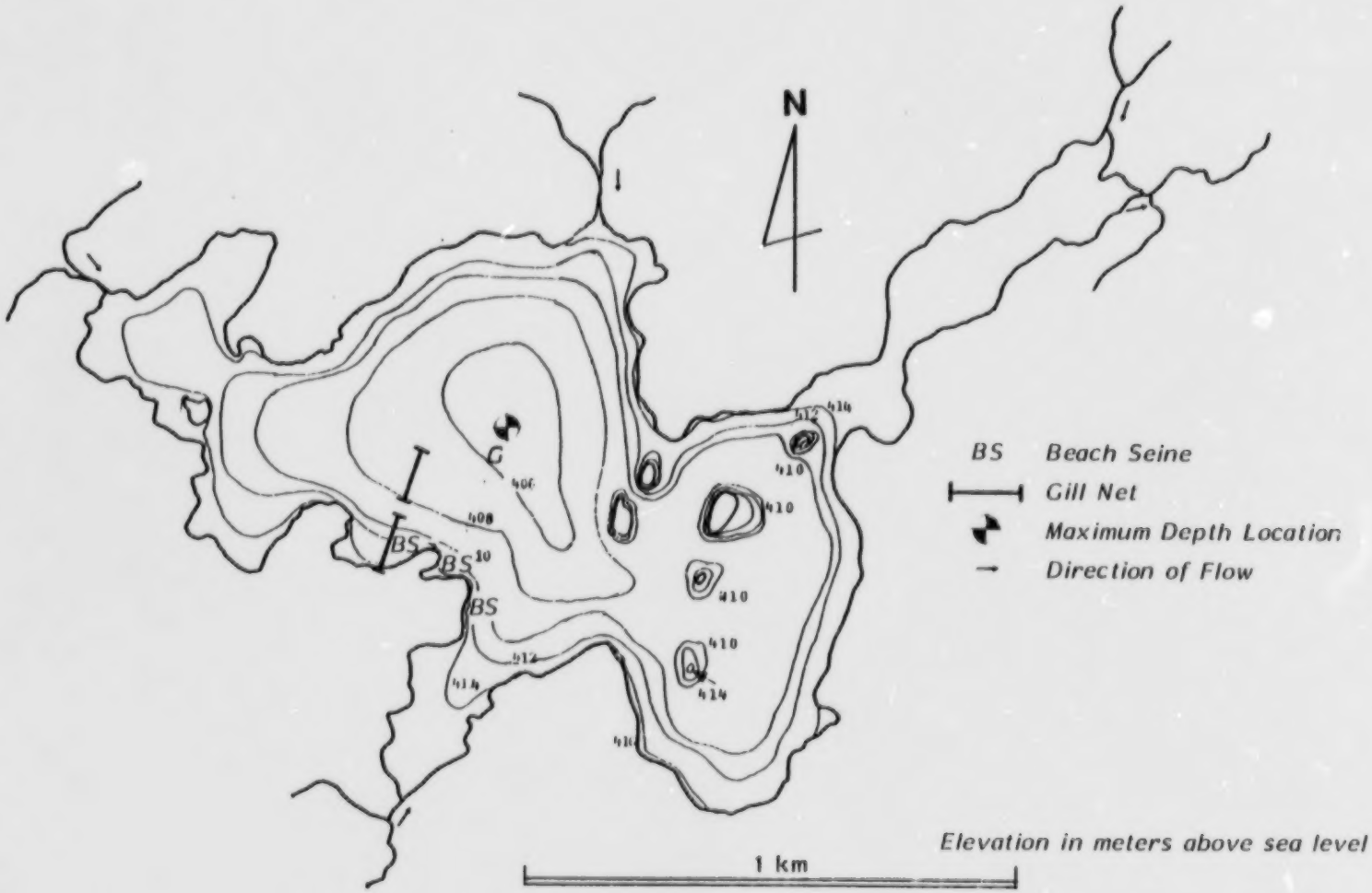


SNOW LAKE

FIGURE 3
SAMPLING LOCATIONS SNOW LAKE - YEAR II



ICY LAKE

FIGURE 4

SAMPLING LOCATIONS ICY LAKE - YEAR II

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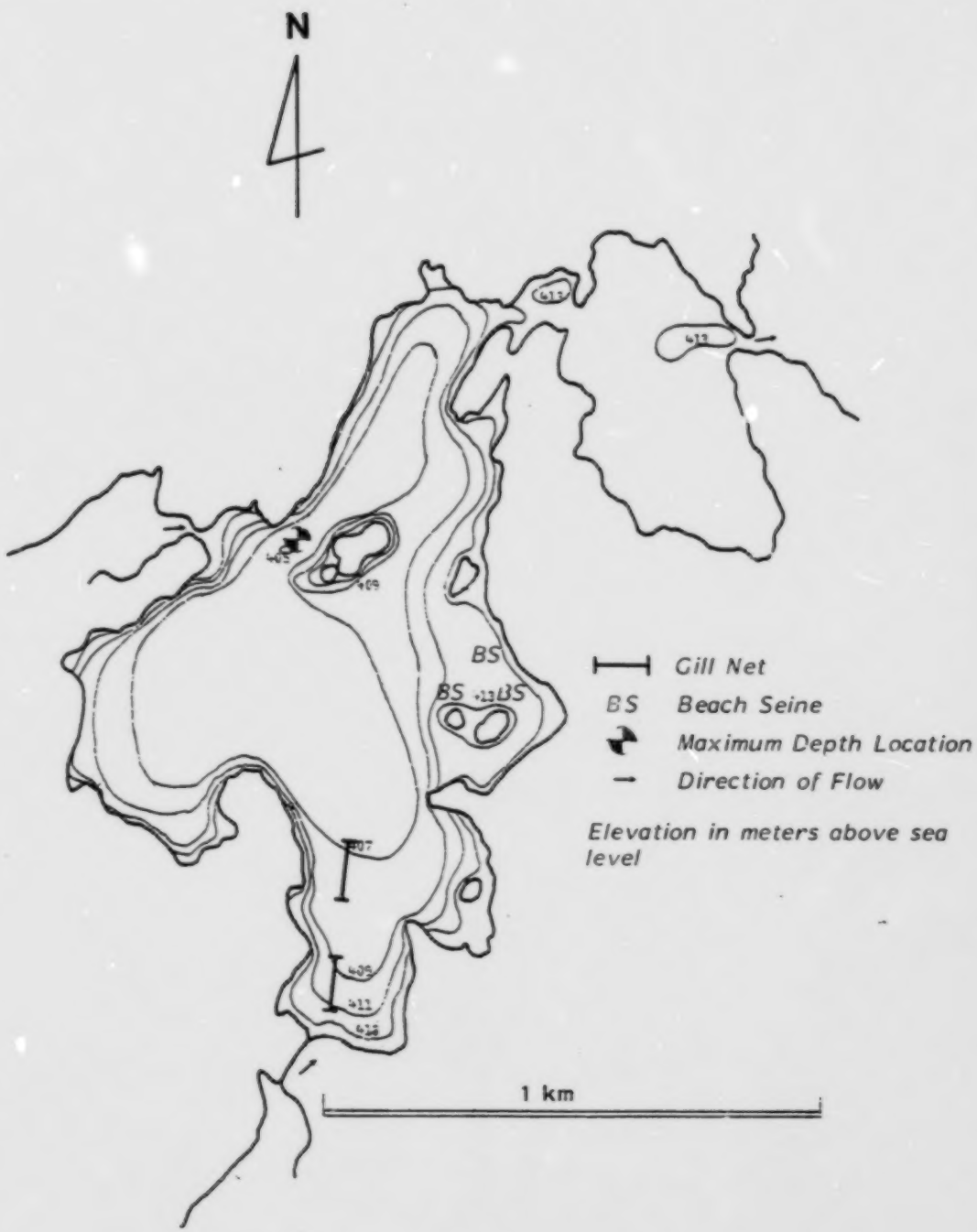

ABIE LAKE

FIGURE 5

SAMPLING LOCATIONS ABIE LAKE - YEAR II

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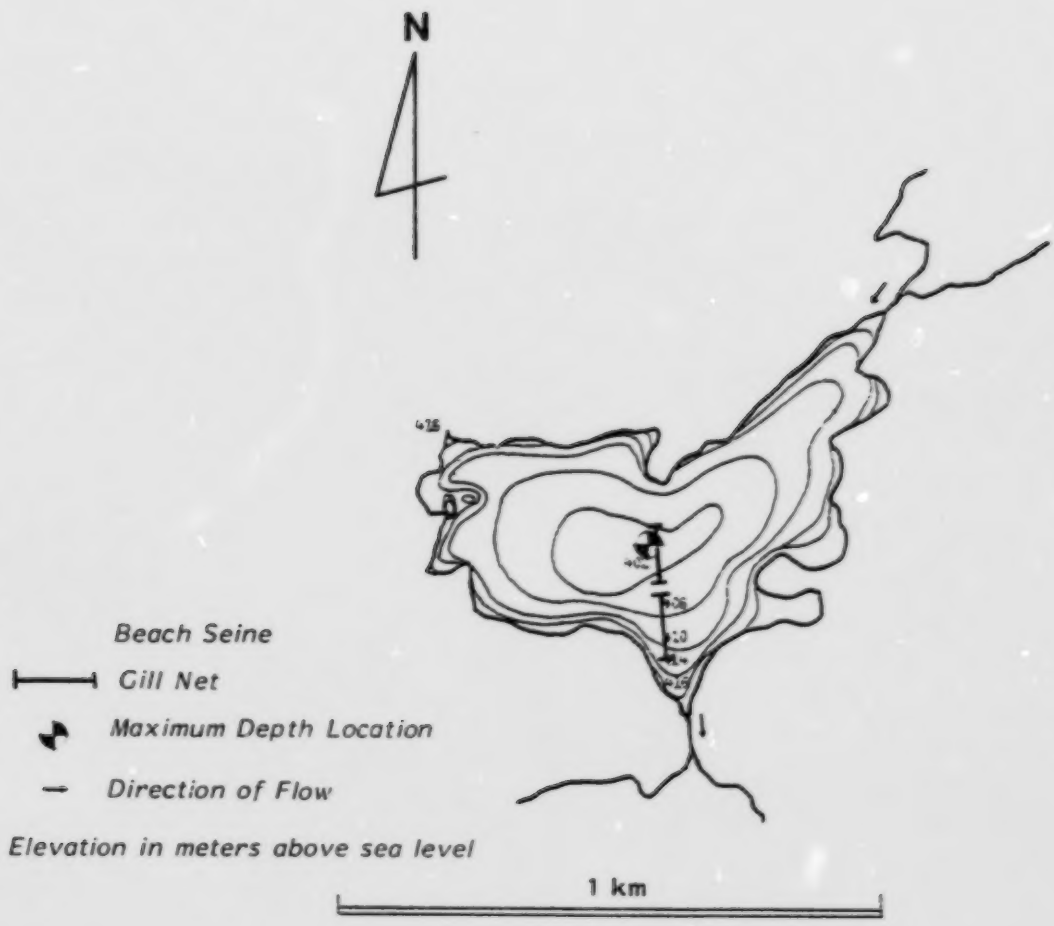
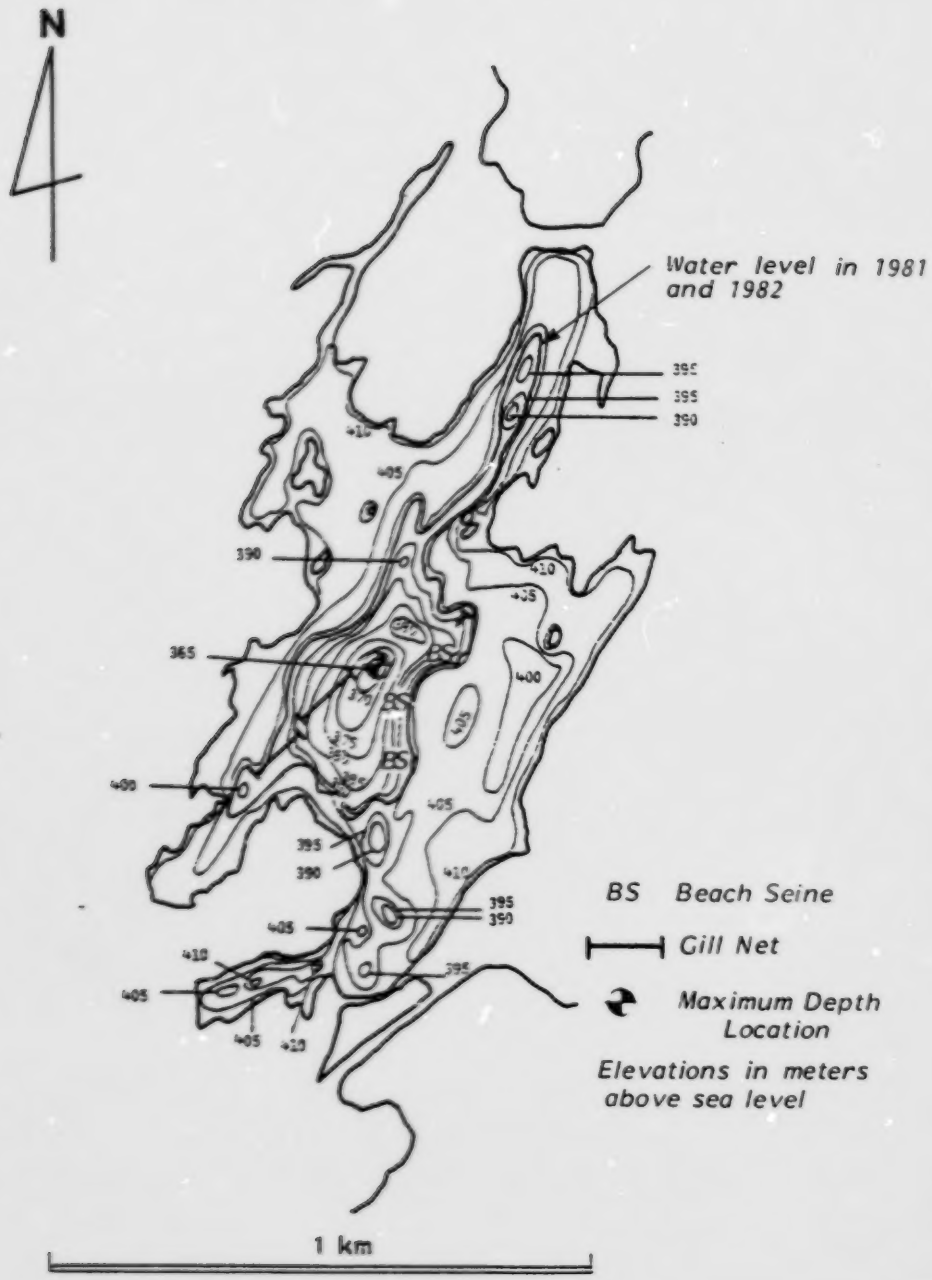


SLUSH LAKE

FIGURE 6

SAMPLING LOCATIONS SLUSH LAKE - YEAR II



MOOSE LAKE

FIGURE 7
SAMPLING LOCATIONS MOOSE LAKE - YEAR II

163895 RD

TABLE 1

SAMPLING SCHEDULE - ATIKOKAN 1982-83

	May	August	October	February
Temperature + Dissolved Oxygen Profiles	X	X	X	X
Temperature Grid		X		
Flow Rates	X	X	X	
Water Chemistry	X	X	X	
Metals in Macrophytes		X		
Metals in Fish		X	X	
Phytoplankton	X	X	X	
Zooplankton	X	X	X	
Macrophytes		X		
Gill Netting	X	X	X	
Beach Seines	X	X	X	

2.1 Physical-Chemical Characteristics

Water Temperatures and Dissolved Oxygen

Temperature and dissolved oxygen profiles were determined with a Hydrolab 4000 meter in May, August, October and February at all locations. Profiles for Marmion Central were not collected in August, October and February.

Peabody-Ryan continuous thermographs were placed near the bottom of Snow and Slush Lakes during the May, August and October sampling periods. These are 20-day thermographs and consequently were only deployed during the visits to the site.

Near surface water temperatures were determined during August along a grid in each of the study lakes. This process was intended to demonstrate any within lake variation in surface temperatures on each lake.

Flow Rates

Flow rates were determined at the outflows of Snow, Icy and Abie Lakes on three occasions in May and October and on two occasions in August according to the sampling technique described in Dodge *et al* (1980). Triplicate current measurements, using a Marsh-McBirney flow meter, were taken at mid-depth at 0.5 or 1 m intervals along a cross-section of the outflow. Water depth at each interval was also recorded. Flow rates were calculated using the following formula

$$D = \sum h_n d_n V_n$$

where D = flow
h = width between velocity measurements
d = depth of water
V = velocity

Water Chemistry

Surface and bottom water samples were collected in May, August and October from the maximum depth location of Snow, Icy, Abie and Slush Lakes and from Marmion South and North and Anderson Dam. Chemical parameters measured are listed in Table 2. Some parameters were not measured in May because of improper sample preservation. With the exception of alkalinity, samples were collected using a Van Dorn bottle. An integrated water column sample was collected using Tygon tubing for alkalinity measurements. In addition, samples were collected from mid-depth of shallow bays of Snow, Icy, Abie and Slush Lakes and Anderson Dam for alkalinity measurements.

TABLE 2

WATER CHEMISTRY PARAMETERS - ATIKOKAN 1982

Turbidity	Calcium
Specific Conductance	Magnesium
pH	Sodium
Total Hardness	Potassium
Alkalinity	Suspended Iron
Non-filtrable Residues	Dissolved Iron
Filtrable Residues	Nickel
Total Silica	Aluminum
Dissolved Silica	Copper
Total Phosphorus	Zinc
Total Kjeldahl Nitrogen	Manganese
Nitrate	Mercury (filtered)
Total Organic Carbon	Arsenic
Total Inorganic Carbon	Selenium
Sulphate	
Chloride	
Ammonia	

Heavy Metals in Biota

Where possible triplicate samples of macrophytes and three walleye, northern pike and white sucker were collected from Snow, Icy, Abie and Slush Lakes and from Anderson Dam. The leaves and stems of the macrophytes and the whole fishes were homogenized and analyzed for iron, copper, zinc, arsenic, aluminum and mercury.

2.2 Biological Characteristics

Macrophytes

The purpose of the 1982 survey was to provide detailed information on the species present, the total bottom cover and the water depth at which emergent, floating leafed and submergent macrophytes grew in selected bays in the study lakes. This information supplements the data collected in 1981, when a more general survey covering macrophyte distribution over a wider area was conducted (Ontario Hydro Research Report No 83-338-K).

Six areas on the cooling circuit were selected for detailed study, and one, a control, was picked on Slush Lake (Figure 8). Four of these were surveyed in 1981. Within each area transects were cruised, and spot checks were made in between to confirm the vegetational patterns apparent along the transects. Voucher specimens of species which were difficult to identify in the field were collected and later identified using the keys in Fassett (1975), Gleason (1968), Voss (1972), Riley (1979), Hellquist and Crow(1980) and Crow and Hellquist (1981). Pondweed identifications were confirmed by G. Millar of the Ontario Ministry of the Environment. Maps were prepared to show the distribution of emergent, floating leafed and submergent vegetation.

Phytoplankton

Phytoplankton samples were collected from Snow Lake, Icy Lake, Abie Lake, Slush Lake and Marmion Lake at Marmion South, Marmion North and Anderson Dam in May, August and October. Samples were taken from above the area of maximum depth at each location with a 3 m PVC tube which sampled the top 3 m of the water column. The phytoplankton were preserved in Lugol's Iodine solution. Data are presented as biomass in mg/m^3.

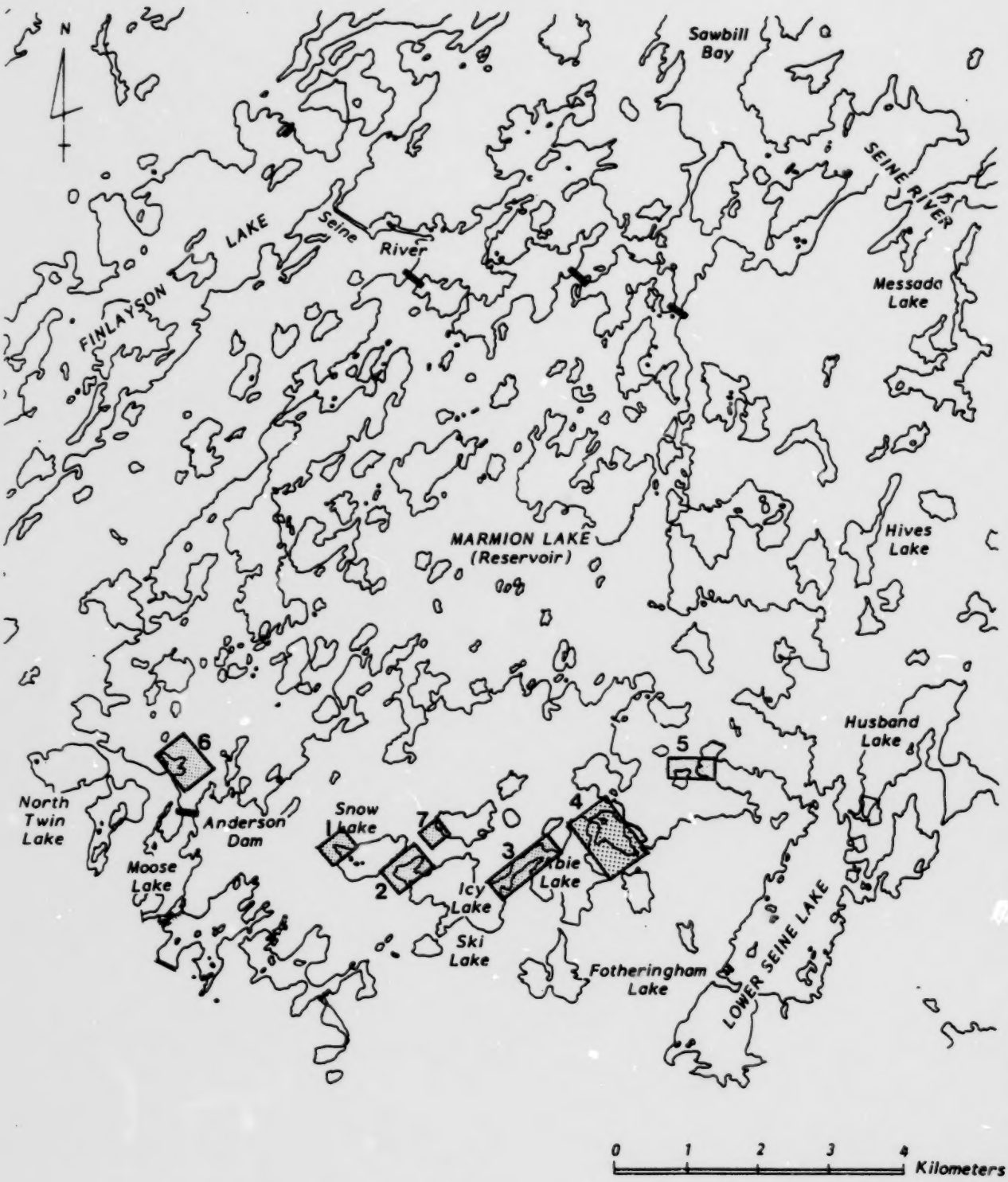


FIGURE 8

MACROPHYTE SAMPLING LOCATIONS IN 1982

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Zooplankton

Zooplankton samples were taken concurrently with phytoplankton samples, using a 27-L Schindler-Patalas plankton trap equipped with 64 µm mesh netting. Integrated samples consisted of duplicate hauls taken at sub-surface (0.5 m) and at 2 m intervals throughout the water column at the maximum depth location. In the field samples were preserved in alcohol which was replaced with 10% formalin in the laboratory. Data are presented as densities in numbers/m^3.

Fish

Gill nets were utilized to sample the adult fish community of each of the ten sampling basins in May, August and October. Two gill net gangs with 15.2 m (50 ft) panels of stretched meshes ranging from 3.8 cm (1.5 in) to 12.7 cm (5.0 in) in increments of 1.3 cm (0.5 in) were set in the evening for a nominal two hour duration. The inshore net was set perpendicular to shore with one end within 10 m of shore and the offshore net was set with one end near the end of the inshore net. All live walleye and northern pike were measured, weighed , tagged and released and a sample of lake whitefish and cisco were measured and weighed.

Young-of-the-year and forage fish were sampled by triplicate beach seines (30.5 m length) during May, August and October at nine locations (Slush Lake excluded because of its steep topography).

In addition, location and timing of walleye spawning was noted during early May and specimens were collected by dip net, weighed, measured, tagged and released.

3.0 RESULTS AND DISCUSSION

3.1 Physical-Chemical Characteristics

3.1.1 Water Temperatures

Temperature profiles taken in May, August, October and February are listed in Appendix 1. Water temperatures in May declined gradually from surface to bottom. Surface water temperatures were generally 2 to 3°C cooler in Marmion Lake than in the upper lakes.

In August a thermocline was apparent at 5 to 7 m in the upper lakes and 8 to 10 m in Marmion Lake. This compares with thermocline depths of 5 to 6 m in the upper lakes and 7 m at the locations in Marmion Lake that were sampled in August of 1981. By

October the shallower lakes, Snow, Icy and Abie, were unithermal while in the deeper basins temperatures were unithermal to 8 m (Slush Lake) or 13 m (Lower Seine and Marmion South) before dropping. In February temperatures increased with depth, with temperatures ranging from 0.0 to 0.5°C at the surface to 3.3 to 4.0°C at the bottom.

In August surface (1 m) water temperatures were taken along a grid pattern. The results (Appendix 2) showed little variation within and among lakes. Maximum within lake variation was 1.0°C and maximum between lake variation was 3.1°C. The magnitude of the between lake variation may be explained by a six day lapse between sampling of the lakes with the warmest (Snow Lake) and coolest (Slush Lake) temperature recordings.

Peabody-Ryan continuous thermographs were placed near the bottom of Snow and Slush Lakes during the May, August and October visits to the site. The result from these thermographs were as expected with a very slight increase in temperature during May, little or no variation in August and a gradual decline in October.

3.1.2 Dissolved Oxygen

Dissolved oxygen profiles are listed in Appendix 1. As in 1981, hypolimnetic oxygen depletion was apparent at all locations sampled. The depths at which oxygen levels reached $\leq$3 mg/L are listed in Table 3. In May oxygen depletion was apparent at 9 m in the upper chain of lakes (Snow, Icy and Abie Lakes) and 14 m in Slush Lake. In Marmion Lake oxygen depletion was only apparent in the deepest basins sampled (Lower Seine and Marmion South). In August oxygen depletion had moved higher in the water column ranging from 5 to 6 m in the upper chain, 10 m in Slush Lake and from 8 to 12 m in Marmion Lake.

In October oxygen levels in the upper chain of lakes were relatively high through the water column while the deeper Slush Lake and Lower Seine and Marmion South in Marmion Lake had oxygen depletion at from 9 to 13 m. In February low oxygen levels again moved up the water column ranging from depths of 7 to 8 m in the upper chain, 12 m in Slush Lake and 16 to 17 m in the deep Marmion Lake locations.

3.1.3 Flow Rates

Flow rates were determined at the outlets of Snow, Icy and Abie Lakes on three occasions in May and October and two occasions in August. The flow rates are summarized in Table 4. Flow rates generally were very low, but were highest in May as would be expected following spring runoff. There was no flow from Snow

TABLE 3

DEPTH (m) AT WHICH O_2 LEVELS WERE $\leq$3 mg/L

	Snow Lake	Icy Lake	Abie Lake	Slush Lake	Marmion Lake				
					Lower Seine	South	Central	North	Anderson Dam
May	9	9[2]	9	14	19[2]	17	-	-	-
August	5	6	6	10	12	9	NS[3]	8	9
October	-[1]	-	9[2]	9	12	13	NS	-	-
February	7	8[2]	8[2]	12	17	16	NS	-	-

1 oxygenated to bottom
2 one metre above bottom
3 not sampled

Lake during August and October as construction of the weir at the Snow Lake outlet had reduced the water level in that basin. In May and October the flow rate into Abie Lake from Icy Lake was higher than that from Abie Lake to Marmion Lake. There are three potential reasons (or a combination thereof) for this difference in flow rate: 1) the instrument used is not accurate at the low velocities measured at the three outlets, 3) there is some seepage from Abie Lake into Marmion Lake through the substrate at the Abie Lake outlet, or 3) that the level of Marmion Lake rose during the sampling periods resulting in a net storage of water in Abie Lake.

TABLE 4

FLOW RATES (m^3/s) AT THE OUTFLOWS OF SNOW, ICY AND ABIE LAKES, ATIKOKAN 1982

		May	August	October
Snow	Mean	0.06	none	none
	Range	0.04 - 0.09		
Icy	Mean	1.36	0.27	0.56
	Range	1.20 - 1.53	0.05 - 0.48	0.30 - 0.95
Abie	Mean	0.73	0.45	0.27
	Range	0.63 - 0.80	0.16 - 0.73	0.08 - 0.56

3.1.4 Water Chemistry

Surface and bottom water chemistry data collected in May, August and October in Snow, Icy, Abie and Slush Lakes and in Marmion Lake at Marmion South, Marmion North and Anderson Dam are presented in Appendix 3. Mean levels in surface and bottom samples from each location as well as ranges of the parameters monitored are presented in Tables 5 and 6.

As in 1981, the study lakes were found to have higher nutrient (nitrate, total phosphorus) and cation (calcium, magnesium, sodium, and potassium) levels than the lakes of the experimental lakes area (ELA) of Northwestern Ontario examined by Armstrong and Schindler (1971) in 1968-1969. Levels of the chemical parameters in our study lakes were similar to those of shield lakes or lakes with partial shield drainage (Armstrong and Schindler, 1971). A similar observation was made in 1981.

TABLE 5

MEAN AND RANGE OF WATER CHEMISTRY PARAMETERS IN SURFACE SAMPLES COLLECTED AT ATIKOKAN
MAY, AUGUST AND OCTOBER, 1982

Parameter	Snow Lake	Icy Lake	Able[1] Lake	Slush Lake	Hanson Lake		
					South	North	Anderson Dam
Turbidity (NTU)	1.0 (0.8-1.3)	1.7 (1.5-2.0)	0.7 (0.5-1.0)	0.8 (0.4-1.3)	1.0 (0.4-1.7)	1.0 (0.5-1.5)	1.6 (0.9-2.3)
Specific Conductance (mS/m)	9.1 (8.3-10.1)	15.0 (13.0-16.0)	11.4 (10.8-12.0)	5.1 (4.6-5.5)	8.9 (7.6-9.7)	7.5 (6.5-9.1)	10.2 (9.1-11.1)
pH	7.0 (6.7-7.4)	7.1 (6.8-7.5)	7.4 (7.3-7.4)	7.0 (6.7-7.2)	7.0 (6.8-7.4)	6.8 (6.6-7.4)	7.1 (6.9-7.5)
Total Hardness ($CaCO_3$, mg/L)[1]	45 (44-46)	66 (65-67)	56 (51-56)	24 (23-25)	40 (38-42)	38 (37-39)	44 (42-46)
Alkalinity (HCO_3 as $CaCO_3$, mg/L)[2]	36 (30-39)	62[3]	51	21 (20-22)	33 (32-36)	27 (24-30)	36 (34-38)
Non-Filtrable Residues 105°C (mg/L)	<2.5 (1.6-4.0)	3.2 (2.0-5.5)	<1.8 (1.5-<2.0)	<2.3 (<2.0-2.8)	<2.1 (1.8-2.5)	<3.0 (1.6-2.5)	3.0 (1.0-4.0)
Non-Filtrable Residues 550°C (mg/L)	<1.5 (<0.5-2.0)	<1.2 (<0.5-<2.0)	<1.5 (1.0-<2.0)	<1.2 (<0.5-<2.0)	<1.5 (<0.5-2.0)	<1.7 (<0.5-2.5)	<1.5 (1.0-<2.0)
Filtrable Residues 105°C (mg/L)	65 (50-74)	99 (92-104)	97 (94-110)	40 (31-44)	66 (60-70)	67 (45-89)	62 (57-64)
Filtrable Residues 550°C (mg/L)	45 (30-55)	73 (63-85)	76 (69-82)	28 (23-33)	44 (37-48)	45 (20-68)	50 (42-65)
Total Silica (mg/L)	2.1 (1.2-3.3)	4.0 (3.0-4.9)	5.6 (3.4-7.8)	2.6 (1.2-5.0)	2.9 (2.2-3.3)	3.2 (3.1-3.3)	3.9 (3.3-4.8)
Soluble Silica (mg/L)	1.2 (0.8-1.5)	3.1 (2.3-4.1)	2.3 (2.1-2.4)	0.9 (0.7-1.1)	2.1 (1.4-2.7)	2.1 (1.7-2.6)	2.5 (1.5-3.1)
Total Phosphorus (mg/L)[1]	0.011 (0.007-0.015)	<0.12 (<0.003-0.020)	<0.015 (<0.003-0.026)	<0.007 (<0.003-0.011)	<0.008 (<0.003-0.013)	<0.009 (<0.003-0.015)	0.017 (0.009-0.024)
Soluble Phosphorus (mg/L)[1]	<0.006 (<0.007-0.015)	<0.008 (<0.003-0.011)	<0.005 (<0.003-0.007)	<0.006 (<0.003-0.008)	<0.004 (<0.003-0.004)	<0.005 (<0.003-0.006)	0.005
Total Kjeldahl Nitrogen (mg/L)	0.14 (0.10-0.18)	0.16 (0.15-0.19)	0.16 (0.14-0.17)	0.10 (0.09-0.10)	0.12 (0.11-0.15)	0.13 (0.10-0.16)	0.12 (0.10-0.13)
Nitrate (mg/L)	<0.25 (0.06-0.58)	<0.08 (0.04-<0.1)	1.5 (0.04-2.9)	0.9 (0.01-2.5)	<1.0 (<0.1-2.8)	<0.12 (0.04-1.2)	<0.13 (0.03-0.27)
Total Organic Carbon (mg/L)	10 (9-11)	11 (8-14)	12 (11-12)	7 (6-8)	9 (8-9)	9 (8-11)	7 (5-9)
Total Inorganic Carbon (mg/L)	7 (5-9)	14 (13-16)	11 (10-12)	5	7 (6-7)	6 (5-6)	8 (7-10)
Sulphate (mg/L)	6.0 (5.0-7.6)	4.1 (4.0-4.6)	4.4 (4.0-4.8)	2.1 (2.0-2.3)	7.5 (6.9-8.3)	7.0 (6.0-8.0)	10.5 (9.0-11)
Chloride (mg/L)	2.1 (1.7-2.5)	5.1 (4.8-5.4)	3.9 (3.8-3.9)	0.8 (0.4-1.7)	1.8 (1.6-2.2)	1.6 (1.5-1.7)	1.9 (1.7-2.1)
Ammonia (mg/L)	<0.07 (<0.01-0.19)	<0.03 (<0.01-0.08)	0.03 (0.01-0.05)	<0.01 (<0.01-0.02)	<0.01 (<0.01-0.02)	<0.04 (<0.01-0.08)	<0.02 (<0.02-0.02)
Calcium (mg/L)[1]	15	21 (20-21)	17 (16-17)		12 (11-12)	11	13 (12-11)
Magnesium (mg/L)[1]	2.1 (1.9-2.2)	3.7 (3.5-3.8)	3.1 (2.8-3.3)	1.0 (0.8-1.2)	2.8 (2.6-2.9)	2.6 (2.4-2.8)	3.2 (3.0-3.4)
Sodium (mg/L)[1]	1.9 (1.8-1.9)	3.9 (3.8-4.0)	3.2 (3.1-3.2)	0.6	2.1 (2.0-2.2)	1.9 (1.8-1.9)	2.2 (2.1-2.2)
Potassium (mg/L)[1]	0.66 (0.60-0.72)	0.97 (0.91-1.02)	0.86 (0.80-0.92)	0.37 (0.34-0.39)	0.68 (0.61-0.72)	0.65 (0.60-0.69)	0.76 (0.71-0.80)
Suspended Iron (mg/L)	0.107 (0.033-0.205)	0.078 (0.048-0.117)	0.055 (0.034-0.076)	0.047 (0.042-0.051)	0.043 (0.042-0.044)	0.045 (0.035-0.061)	0.121 (0.048-0.207)
Dissolved Iron (mg/L)[1]	0.09 (0.08-0.10)	0.14 (0.08-0.20)	<0.06 (<0.05-0.07)	<0.05	<0.05	0.06 (0.05-0.07)	0.13 (0.10-0.16)
Nickel (mg/L)[1]	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Aluminum (mg/L)[1]	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Copper (mg/L)[1]	0.005 (0.001-0.008)	<0.005 (<0.001-0.009)	0.001 (0.002-0.001)	<0.002 (<0.001-0.003)	<0.002 (<0.001-0.001)	0.006 (0.002-0.010)	0.003 (0.001-0.005)
Zinc (mg/L)[1]	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Manganese (mg/L)[1]	0.04	0.18 (0.12-0.24)	0.04 (0.03-0.04)	<0.03 (<0.02-0.03)	0.04 (0.03-0.04)	0.06 (0.04-0.07)	0.03
Mercury (Filtered) (mg/L)	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Arsenic (mg/L)[1]	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002 (<0.002-0.00.)
Selenium (mg/L)[1]	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002 (<0.001-0.002)

1 August and October Samples Only
2 Surface to Bottom Samples
3 August Sample Lost

TABLE 6

MEAN AND RANGE OF WATER CHEMISTRY PARAMETERS IN BOTTOM SAMPLES COLLECTED AT ATIKOKAN
MAY, AUGUST AND OCTOBER, 1982

Parameter	Snow Lake	Icy Lake	Able[1] Lake	Slush Lake	Hemlon Lake		
					South	North	Anderson Dam
Turbidity (NTU)	1.3 (1.0-1.5)	1.9 (1.3-2.0)	0.91 (0.71-1.1)	1.3 (0.43-2.0)	1.1 (0.50-2.1)	1.02 (0.47-1.7)	1.5 (0.88-2.0)
Specific Conductance (mS/m)	9.3 (8.3-10.5)	14.9 (13.7-16.0)	12.0 (11.5-12.4)	5.4 (4.8-6.0)	9.5 (8.4-10.0)	7.6 (6.8-9.1)	10.1 (9.0-11.1)
pH	6.8 (6.5-7.4)	7.1 (6.7-7.5)	7.3 (7.1-7.5)	6.4 (6.1-6.5)	6.8 (6.4-7.2)	6.9 (6.5-7.3)	7.2 (6.8-7.5)
Total Hardness ($CaCO_3$) (mg/L)[1]	44 (42-46)	69 (65-73)	56 (55-56)	26 (24-27)	42 (41-42)	42 (38-46)	47
Non Filtrable 105°C (mg/L)	2.8 (<2.0-4.0)	<3.2 (<2.0-5.5)	<1.5 (<1-<2)	2.6 (2.4-3.0)	<2.4 (<2.0-2.6)	<2 (<1-3)	2.8 (2.0-4.0)
Residues 550°C (mg/L)	<1.7 (1.0-2.0)	<2.2 (<0.5-4.5)	<1.5 (<1-<2)	1.2 (<0.5-2.0)	<1.5 (1-<2.0)	<1.3 (<1-<2)	<1.9 (1.8-2.0)
Filtrable 105°C (mg/L)	68 (49-89)	96 (82-104)	91 (89-93)	48 (28-70)	72 (62-80)	60 (46-70)	71 (64-77)
Residues 550°C (mg/L)	49 (32-68)	75 (65-88)	64.5 (64-65)	35 (18-61)	51 (44-59)	41 (22-51)	49 (42-56)
Total Silica (mg/L)	4.5 (2.0-7.2)	5.4 (4.3-6.6)	3.9 (3.8-4.0)	2.5 (2.3-2.7)	3.4 (2.2-4.8)	4.3 (3.6-4.9)	4.1 (4.0-4.2)
Soluble Silica (mg/L)	3.7 (1.3-2.1)	4.1 (3.0-4.9)	3.4 (3.3-3.4)	1.8 (0.8-2.4)	1.9 (1.5-2.4)	2.4 (1.8-3.3)	1.8 (1.2-2.3)
Total Phosphorus (mg/L)[1]	0.030 (0.014-.061)	0.032 (0.004-0.060)	0.021 (0.006-0.036)	0.023 (0.020-0.026)	0.009 (0.003-0.016)	0.015 (0.008-0.022)	0.019 (0.010-0.029)
Soluble Phosphorus (mg/L)[1]	<0.008 (<0.003-0.013)	<0.008 (<0.003-0.014)	<0.008 (<0.003-0.013)	<0.010 (<0.003-0.020)	<0.007 (<0.003-0.012)	<0.010 (<0.003-0.017)	0.016 (0.009-0.023)
Total Kjeldahl Nitrogen (mg/L)	0.15 (0.10-0.20)	0.20 (0.18-0.24)	0.26 (0.15-0.31)	0.12 (0.10-0.15)	0.14 (0.12-0.15)	0.13 (0.12-0.14)	0.14 (0.13-0.15)
Nitrate (mg/L)	<0.72 (0.06-2.0)	0.13 (0.01-0.30)	0.06 (0.05-0.06)	0.03 (<0.10-1.70)	<0.48 (0.03-1.3)	<0.42 (<0.10-1.20)	<0.97 (<0.10-2.80)
Total Organic Carbon (mg/L)	9.7 (8.0-11.0)	11.3 (9.0-14.0)	11.0	9.3 (7.0-13.0)	9.0 (8.0-10.0)	9.0 (8.0-11.0)	7.3 (5.0-9.0)
Total Inorganic Carbon (mg/L)	8.0 (6.0-11.0)	15.0 (13.0-19.0)	12.5 (11.0-14.0)	6.0 (5.0-7.0)	6.7 (6.0-8.0)	6.3 (6.0-7.0)	8.3 (7.0-10.0)
Sulphate (mg/L)	5.5 (3.6-7.9)	4.1 (4.0-4.4)	4.4 (4.1-4.6)	1.9 (1.8-2.0)	7.9 (7.2-8.3)	6.7 (5.7-7.2)	10.2 (9.0-12.0)
Chloride (mg/L)	5.5 (1.8-11.0)	5.2 (4.9-5.4)	4.0 (3.9-4.1)	1.8 (0.5-4.3)	2.1 (2.0-2.5)	1.4 (1.3-1.5)	1.8 (1.7-2.1)
Ammonia (mg/L)	0.02 (0.01-0.04)	0.05 (0.02-0.08)	0.04 (0.02-0.05)	0.01 (0.01-0.06)	0.02 (0.01-0.03)	0.02 (0.01-0.02)	<0.02 (<0.01-0.03)
Calcium (mg/L)[1]	15 (14-15)	22 (20-23)	17	9 (8-9)	12	12 (11-12)	13
Magnesium (mg/L)[1]	2.0 (1.8-2.2)	3.8 (3.7-3.8)	3.2 (3.0-3.4)	1.1 (0.9 1.2)	2.9 (2.8-3.0)	3.1 (2.5-3.6)	3.5
Sodium (mg/L)[1]	1.8 (1.6-1.9)	4.0 (3.8-4.1)	0.7	0.66	2.1 (2.0-2.2)	1.9	2.1
Potassium (mg/L)[1]	0.65 (0.57-0.72)	1.01 (1.02-1.01)	0.88 (0.84-0.91)	0.43 (0.40-0.46)	0.67 (0.68-0.72)	0.68 (0.61-0.72)	0.80
Suspended Iron (mg/L)	0.105 (0.047-0.155)	0.139 (0.076-0.220)	0.062 (0.056-0.069)	0.125 (0.078-0.207)	0.044 (0.038-0.048)	0.063 (0.048-0.077)	0.141 (0.078-0.215)
Dissolved Iron (mg/L)[1]	0.19 (0.18-0.19)	0.24 (0.19-0.29)	0.90 (0.08-0.10)	0.18 (0.10-0.25)	<0.05 (<0.05-0.05)	0.09 (0.05-0.13)	0.17
Nickel (mg/L)[1]	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Aluminum (mg/L)[2]	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Copper (mg/L)[1]	0.002 (0.001-0.002)	0.011 (0.001-0.020)	0.004 (0.001-0.006)	0.003 (0.002-0.003)	<0.003 (<0.001-0.004)	0.004 (0.001-0.006)	0.002
Zinc (mg/L)[1]	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Manganese (mg/L)[1]	0.27 (0.04-0.50)	<0.02	0.11 (0.05-0.16)	<0.26 (<0.10-0.42)	0.07 (0.05-0.08)	0.12 (0.08-0.17)	0.03
Mercury (Filtered) (mg/L)	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Arsenic (mg/L)[1]	<0.002	<0.003 (<0.002-0.004)	<0.002	<0.002	<0.002	<0.002	<0.002
Selenium (mg/L)[1]	<0.002	<0.002	<0.003 (<0.002-0.003)	<0.002	<0.002	<0.002	<0.001

[1] August and October Samples Only

The lakes studied in 1982 were found to have low alkalinity with moderate levels of nutrients and ions. Copper and manganese were the only metals present in detectable concentrations.

The pH of the lakes were generally close to neutral with mean surface pH ranging from 6.8 at Marmion North to 7.1 at Icy Lake and Anderson Dam. At the bottom of the water column it ranged from 6.4 at Slush Lake to 7.2 at Anderson Dam. pH showed some seasonal variation with lowest pH found in May at all locations. Abie Lake which was not sampled in May was not included in this comparison. In 1981 the mean pH of the lakes were lower than they were found to be in 1982 and were described as slightly acidic. However, differences in sampling times and locations may account for this apparent difference.

Several differences were found between the levels of water chemistry parameters estimated in 1981 and 1982. Marmion Lake was found to have lower total and soluble phosphorus levels in surface waters in 1982 than in 1981. Surface and bottom total Kjeldahl nitrogen levels in the three lakes sampled in both years (Icy, Slush and Marmion Lakes) were lower in 1982 as well. Surface suspended iron levels were higher in Icy Lake and at Marmion South and Anderson Dam in 1982 than in 1981.

Comparison of Lakes

Icy Lake was the most turbid lake (approximately 2.0 NTU) with highest levels of non-filtrable (32 mg/L) and filtrable residues (66 and 69 mg/L at surface and bottom, respectively). Specific conductance, a measure of the ionic content of the water, was highest in Icy Lake (15 mS/m). Indeed, levels of the ions calcium, manganese, sodium, chloride and potassium (21, 4, 4, 5 and 1 mg/L, respectively) were all found to be higher in Icy Lake than at most of the remaining locations, both at the bottom and surface of the water column.

At the surface of the water column, levels of some of the nutrients were higher in Icy and Abie Lakes than in most of the remaining lakes. Surface concentrations of total Kjeldahl nitrogen (0.2 mg/L) and total silica (4.0 and 5.6 mg/L in Icy and Abie Lakes, respectively) were highest in these two lakes while total phosphorus (12 and 15 mg/L, respectively) was higher in these lakes than at all of the other locations with the exception of Anderson Dam (17 mg/L). Surface nitrate levels on the other hand were lowest in Icy Lake (<0.08 mg/L) and highest in Abie Lake (1.5 mg/L). Levels of total organic carbon and total inorganic carbon were also higher in Icy and Abie Lakes, both at the surface (11 and 14 mg/L, and 12 and 12 mg/L, respectively) and bottom (11 and 15 mg/L, and 11 and 13 mg/L, respectively) of the water column.

Icy Lake also had the highest alkalinity (62 mg/L, HCO_3 as $CaCO_3$) and measure of hardness (66 and 69 mg $CaCO_3$/L at the surface and bottom, respectively).

In contrast to Icy Lake, Slush Lake had lower levels of most of the above parameters than was estimated for the other locations. It had the lowest levels of filtrable residues (40 and 48 mg/L at surface and bottom, respectively), alkalinity (21 mg/L), hardness (24 and 26 mg/L at surface and bottom, respectively), specific conductance (5 mS/m) and the ions, calcium (8.1 and 8.6 at surface and bottom), magnesium (1 mg/L), sodium (0.6 and 0.7 mg/L at surface and bottom), sulphate (2 mg/L), chloride (0.8 and 1.8 mg/L at surface and bottom), and potassium (0.4 mg/L). Surface total phosphorus (<7 mg/L), Kjeldahl nitrogen (0.1 mg/L) and total silica (2.6 mg/L) levels were estimated to be lower in Slush Lake than in most of the other lakes. Total inorganic carbon levels were also lowest in Slush Lake (5 and 6 mg/L at surface and bottom). These parameters were also relatively low in Slush Lake in 1981.

Abie Lake was the least turbid of the study lakes (0.7 and 0.9 NTU, at surface and bottom, respectively) and had the lowest levels of non-filtrable residues (<1.8 and <1.5 mg/L).

Nickel, aluminum, zinc and mercury, occurred in concentrations below their respective analytical detection levels in all the study lakes. Copper was detected in all lakes with highest levels at the surface of Marmion North (0.006 mg/L) and at the bottom of Icy Lake (0.011 mg/L). This element, which was not detected in the study lakes in 1981 was found in levels exceeding the MOE objective (MOE, 1978) for the protection of aquatic life (0.005 mg/L) in August at Marmion North (0.01 and 0.006 mg/L at surface and bottom, respectively), Icy Lake (0.009 and 0.02 mg/L, respectively) and at Marmion North (0.008 mg/L at the surface).

Mean levels of suspended iron were highest at Anderson Dam and dissolved iron concentrations were highest at Icy Lake (0.14 mg/L and 0.24 mg/L, respectively). Manganese levels were highest in Icy Lake (0.2 mg/L) at the surface and highest in Snow Lake at the bottom (0.3 mg/L). Arsenic and selenium were only detected in the surface samples from Anderson Dam (<0.0002 mg/L), each). In the bottom samples arsenic was only detected at Icy Lake (<0.003 mg/L). The higher levels of some metals at Anderson Dam may be related to the deposition of mine spoils in that area.

Alkalinity Measurements in the Bays

Alkalinity measurements for bays in Snow Lake, Icy Lake, Slush Lake, Abie Lake (locations 3 and 6) and at Anderson Dam (Table 7) indicated that alkalinity in the bays were similar to those measured at the maximum depths (Table 4) in the corresponding lakes. Alkalinity in the bays was highest in Icy Lake (56 mg/L) and lowest in Slush Lake (21 mg/L).

TABLE 7

ALKALINITY LEVELS IN BAY AREAS OF SNOW LAKE, ICY LAKE, SLUSH LAKE, ABIE LAKE AND AT ANDERSON DAM ATIKOKAN TGS PREOPERATIONAL STUDY 1982

	Snow Lake	Icy Lake	Slush Lake	Abie Lake		Anderson Dam
				Loc 3	Loc 6	
	HCO_3 as $CaCO_3$ in mg/L					
May	35	59	22	49	47	36
August	38	48	19	45	49	35
October	39	60	20	51	48	34
Mean	37	56	21	48	48	35

3.1.5 Heavy Metal Levels in Aquatic Biota, Water and Sediments

Macrophytes for the determination of heavy metal levels were collected from Slush Lake, Icy Lake, Abie Lake, and Anderson Dam. The macrophytes collected from Slush Lake consisted almost exclusively of the pondweed *Potamogeton zosteriformis* while those collected from Icy and Abie Lakes were *P. robbinsii*. Macrophytes from Anderson Dam consisted of a mixture of species but the dominant taxa collected were *P. zosteriformis* and *Myriophyllum exalbescens*. Fish species analyzed for heavy metals were white sucker and northern pike taken at Slush Lake, Icy Lake, Abie Lake and Anderson Dam, and walleye caught in Icy Lake and at Anderson Dam. Analyses were conducted on the leaves and stems of the macrophytes and on whole fish. Mean levels presented are based on triplicate samples (Table 8).

Iron and copper were the only metals found in detectable levels in water samples from all four locations. Iron levels in the water and in macrophytes were higher in Abie Lake than at the remaining locations. Mean iron levels in the macrophytes ranged from 1626 to 3876 mg Fe/kg dry weight. Iron levels were highest in white sucker and northern pike from Slush Lake (104 mg/kg and 58 mg/kg, respectively). Walleye collected in Icy Lake had higher levels of iron than those taken from Anderson Dam (59 and 11 mg/kg, respectively). Levels in fish in a South Carolina reservoir ranged from 39 in chain pickerel to 149 mg/kg in brook silverside (Giesy and Weiner 1977, in Phillips and Russo 1978). With the exception of fish from Slush Lake, levels of iron in the fish from our study lakes were below this range.

Copper levels were highest in macrophytes from Abie Lake (6.5 mg/kg). In the water, copper levels were highest in Icy Lake. Levels in white sucker and northern pike ranged from 1.4 to 2.3 mg/kg and 0.8 to 1.1 mg/kg, respectively, and were highest in fish taken from Slush Lake. Levels in walleye from Icy Lake and Anderson Dam were 1.1 and 1.4 mg/kg, respectively. Goettl et al (1972, in Phillips and Russo 1978) found baseline concentrations in rainbow trout in a hatchery with a pristine water supply to be 1.7 mg Cu/kg which is within the range found for the fish from our study area.

Zinc which occurred in levels below the analytical detection limit in water samples, was found in concentrations of 11 to 27 mg/kg in the macrophytes. Highest mean concentration was found in macrophytes from Slush Lake. The concentrations in macrophytes from our study lakes were lower than those recorded by Wells et al (1980) for macrophytes from Saginaw Bay, Lake Huron, and from a lake in Michigan. They found levels of Zn in *Potamogeton* from Saginaw Bay, Lake Huron to range from 22 to 458 mg/kg. The mean level they recorded for this genus in a lake in Michigan was 45 mg/kg. Mean levels in white sucker ranged from 15 to 22 mg Zn/kg and in northern pike it ranged from 17 to 26 mg/kg with highest levels in both species found in fish taken in Abie Lake. Walleye from Icy Lake and Anderson Dam contained mean levels of 16 and 17 mg/kg, respectively.

Arsenic levels were highest in macrophytes from Icy Lake where water content of arsenic was also highest. The mean As levels in the macrophytes range from 0.7 to a high of 20.7 mg/kg. Arsenic levels in *Potamogeton* species in Saginaw Bay, Lake Huron, range from 0.4 to 1.7 mg/kg while the levels in this genus in a lake in Michigan was estimated to be 0.3 mg/kg (Wells et al, 1980). Compared to these levels the mean levels of arsenic in the macrophytes from all our study locations except Anderson Dam appear to be on the high side. Mean levels

in white sucker and walleye were less than 0.6 mg/kg from all locations. In northern pike highest mean concentration of 1.1 mg As/kg was estimated for fish taken from Slush Lake. The average concentration of arsenic in fish species monitored in Southern USA was estimated at 0.75 mg/kg (Phillips and Russo 1978).

Aluminum levels in the macrophytes ranged from 987 mg/kg in Anderson Dam to 2304 mg/kg in Icy Lake. As was found with the iron concentrations, Al concentrations were also substantially higher in the macrophytes than in the fish. In the white suckers it ranged from 17 in fish from Slush Lake to 58 mg Al/kg in fish from Icy Lake. Mean levels of Aluminum in northern pike ranged from 12 to 49 mg/kg with highest levels also found in fish from Icy Lake. The mean aluminum level in walleye was less than 21 mg/kg in fish from Icy Lake and 9 mg/kg in fish from Anderson Dam. The average Al concentrations in decapitated lake trout from a New York lake averaged from 140 to 300 mg/kg (Phillips and Russo 1978) which is substantially higher than the levels we found for fish from our study area.

Mercury measurements were only made on white sucker from Slush, Icy and Abie Lakes and on northern pike from Slush Lake. The mean levels in white sucker ranged from 0.4 to 1.1 mg Hg/kg with highest levels found in fish from Slush Lake. The concentration was 2.9 mg Hg/kg in northern pike from Slush Lake. The MOE limit for the protection of human consumers of fish is 0.5 mg Hg/kg wet weight for whole fish (MOE 1978). Assuming moisture content of the fish to be 75% (Diana 1983), the mean mercury content of the white sucker on a wet weight basis would range from 0.1 to 0.3 mg/kg. Mean Hg content of northern pike from Slush Lake was in excess of the MOE (1978) guideline at 0.7 mg/kg wet weight. Acres (1976) reported levels of mercury in northern pike from Sawbill Bay (directly northeast of Marmion Lake proper) of 1.0 and 1.2 mg/kg wet weight and observed that these values were similar to those reported by MNR in Icy Lake in 1975. Levels of Hg in Northern Pike from Icy Lake ranged from 0.19 to 0.57 gm/kg wet weight in 1975 (Sherbin 1979).

The levels of iron, copper, zinc, arsenic and aluminum were all substantially higher in the macrophytes than in the water. The enrichment of elements in plants is highly species specific (Aulio and Salin, 1982) and it was therefore not possible to compare the ratios of the levels of the elements in the water and the macrophytes to a typical ratio. The species specific accumulation of elements may be a result of factors such as differences in a morphological characteristics and specific features in metal absorption through roots and/or shoots (Denny 1980, in Aulio and Salin 1982).

An example of copper enrichment in the duckweed, *Lemna valdiriana*, is given by Hutchinson and Czyrska 1975, in Demayo *et al* 1982) who found levels of copper in the macrophytes to be 10 000 times the concentration in their culture solution with the ratio apparently increasing at the higher levels of copper in solution.

The concentrations of iron, copper, zinc and aluminum in the sediment of Slush Lake, Icy Lake, Abie Lake and at Anderson Dam were measured in 1981 and are presented in Table 8. Compared to the levels in the substrate, the levels of copper in the macrophytes were lower while concentrations of zinc were higher in the macrophytes. No consistent differences were apparent between the levels of iron and aluminum in the macrophytes and the sediment. However, the levels of both these elements at Anderson Dam were considerably lower in the macrophytes than in the sediment.

Levels of copper and zinc in macrophytes have been found to be correlated with levels in the sediment. Patrick and Loutit (1977 in Taylor *et al* 1982) found that up to 40% of zinc associated with submerged macrophytes was contained in epiphytes and when the epiphytes were removed, the amount of zinc in macrophytes with roots, and the metabollic activity of the plant appeared to be correlated with the amount of zinc in the sediment. Mudrock and Capobianco (1979, in Demayo *et al*, 1982) found a correlation between total copper in the sediments and in two macrophyte species. Although the sampling effort in the current study was not as intensive as those presented above, the levels of copper and zinc in the macrophytes appeared to be related to levels in the sediment.

Metal levels were also generally higher in the fish than in the water. In the case of fish, metal uptake may occur through ingestion of food and/or directly from the water through the gills, depending on the metal. Iron was higher in white sucker than in northern pike while copper levels were higher in white sucker than in pike and walleye. Higher levels of copper in white sucker compared to these in the two piscivores is in agreement with Windom *et al's* (1973) observation that copper levels are inversely related to trophic status. No consistent difference was found between the levels of zinc in the three fish species although several researchers (Mathis and Cummings 1973; Namminga *et al* 1974, in Taylor *et al* 1982) have found omnivorous fish to have higher levels of zinc than carnivorous fish. Delisle *et al* (1975, in Taylor *et al* 1982) found bottom feeders to have higher levels of zinc than mid-water feeders.

TABLE 8

MEAN LEVELS (mg/kg DRY WEIGHT) OF HEAVY METALS IN WATER, SEDIMENTS, MACROPHYTES AND FISH FROM ATIKOKAN GS STUDY LAKES - 1982

Element	Source	Slush Lake	Icy Lake	Abie Lake	Anderson Dam
		mg/kg (mg/L) ± SD			
Iron	Water (mg/L)	<0.201	0.299	0.539	0.282
	Macrophytes	1626 ± 900	3093 ± 1551	3866 ± 2141	562 ± 282
	Walleye		59.3 ± 41.7		11.4 ± 0.2
	White Sucker	104 ± 36	17.7 ± 1.3	28.7 ± 26.7	18.7 ± 3.9
	Northern Pike	58 ± 6.9	13.2 ± 1.6	12.4 ± 3.4	8.3 ± 1.7
	Sediment (1981)	2500	2800	3200	4400
Copper	Water (mg/L)	0.003	0.008	0.004	0.003
	Macrophytes	3.0 ± 1.0	4.1 ± 0.6	6.5 ± 0.6	5.6 ± 0.8
	Walleye		1.1 ± 0.2		1.4 ± 0.2
	White Sucker	2.3 ± 0.4	1.4 ± 0.3	1.4 ± 0.7	1.7 ± 0.7
	Northern Pike	1.1 ± 0.4	0.8 ± 0.2	0.8 ± 0.1	<1.1 ± 0.8
	Sediment (1981)	9	14	8	6
Zinc	Water (mg/L)	<0.02	<0.02	<0.02.	<0.02.
	Macrophytes	27.2 ± 9.6	11.0 ± 0.5	19.6 ± 1.3	15.1 ± 1.1
	Walleye		16.1 ± 0.8		17.3 ± 2.4
	White Sucker	15.4 ± 0.6	21.8 ± 1.3	22.2 ± 7.6	18.5 ± 2.5
	Northern Pike	21.7 ± 0.4	23.4 ± 7.1	25.9 ± 5.0	17.3 ± 2.4
	Sediment (1981)	10	8	9	9
Arsenic	Water (mg/L)	<0.002	<0.002	<0.002	<0.002
	Macrophytes	3.1 ± 2.7	20.7 ± 4.7	6.6 ± 3.0	0.7 ± 0.3
	Walleye		0.3 ± 0.2		<0.6
	White Sucker	0.4 ± 0.1	<0.6	<0.3 ± 0.2	<0.6
	Northern Pike	1.1 ± 0.4	<0.7 ± 0.2	<0.6	<1.0 ± 0.4
Aluminum	Water (mg/L)	<0.5	<0.5	<0.5	<0.5
	Macrophytes	1706 ± 1297	2304 ± 1936	1076 ± 724	987 ± 345
	Walleye		<21.0 ± 10.7		91.7 ± 53.6
	White Sucker	17 ± 7.2	58 ± 31	29.8 ± 16.6	31.7 ± 7.4
	Northern Pike	12 ± 4.4	49 ± 29	37.0 ± 18.2	<35.7 ± 17.2
	Sediment (1981)	13	25	20	30
Mercury	Water (mg/L)	<0.0002	<0.0002	<0.0002	<0.0002
	Macrophytes				
	Walleye				
	White Sucker	1.1 ± 0.2	0.99 ± 0.61	0.40 ± 0.32	
	Northern Pike	2.9 ± 0.6			

Levels of arsenic were generally higher in the northern pike than walleye and white sucker. Wiebe et al (1931, in Phillips and Russo 1978), working on bass, found that arsenic was readily accumulated by fish both by exposure to arsenic in food and water.

No consistent difference between mean aluminum levels in the three fish species was obvious.

Mean mercury levels were higher in northern pike from Slush Lake than in white sucker from the same lake. Fish apparently can accumulate high levels of Hg because accumulation is rapid while elimination is slow (NRCC 1979). Mercury, which can be absorbed through the gills and food, is found in higher levels in predators than in fish lower in the food chain with highest levels in Canadian freshwater fish found in lake trout, pike and walleye (NRCC 1979).

In the current study lengths were not recorded on all fish collected. However, differences in metal concentrations in fish among the basins sampled did not appear to be related to differences in fish size. For example, although the average size of northern pike from Abie Lake (529 mm) was less than those from Anderson Dam (659 mm) concentrations of iron, zinc and aluminum were higher in pike from Abie Lake.

3.2 Biological Characteristics

3.2.1 Macrophytes

Species Composition

A list of the species found in 1982 and the lakes in which they occurred is presented in Table 9. Thirty-two of the species are submergents and floating leafed species, eleven are emergents and one is a macrophytic alga (Charophyte). Eight of the species were not observed in 1981, while 12 of the species present in 1981 were not observed in 1982. The change in species composition is attributable in part to differences in the sampling locations between the two years and in part to environmental disturbances such as the drawdown in Snow Lake. The drawdown resulted in the exposure of a mudflat which was being colonized by cattails (*Typha* sp). Species which previously occupied the area include *Eriocaulon septangulare* (pipewort), *Lobelia dortmanna* (water lobelia) and *Sparganium fluctuans* (floating leaf bur reed), all of which require standing water for their existence. None of the eight new species in the study area are on Argus and White's (1977) list of rare vascular plants of Ontario and all have some value as food for wildlife (Table 10, Fassett 1957).

TABLE 9

MACROPHYTE SPECIES LIST FOR THE ATIKOKAN STUDY LAKES - 1982

	Snow	Icy	Abie	Slush	Marmion
Macrophytes					
Brasenia schreberi Gmel.			X		
Callitriche hermaphroditica L.		X			X
Callitriche heterophylla Pursh.					X
Calmagrostis canadensis (Michaux) Beauv.					X
Ceratophyllum demersum L.					X
Dulichium arundinaceum (L.) Britton			X	X	
Eleocharis acicularis (L.) R&S			X		X
Elodea canadensis (Michx.) Rich	X	X			X
Equisetum sp.		X			
Glyceria borealis (Nash) Batch			X		X
Glyceria grandis S. Watson				X	X
Hippuris vulgaris L.				X	
Lemna sp.				X	
Myriophyllum alterniflorum D.C.		X			X
Myriophyllum exalbescens Fern.		X	X		X
Najas flexilis (Willd.) Rostk, & Schmidt	X	X	X	X	X
Nuphar sp.			X	X	
Nymphaea odorata Ait.		X	X	X	X
Polygonum natans Eat.			X		X
Potamogeton alpinus Balbis					X
Potamogeton amplifolius Tuckerm.					X
Potamogeton ephydrus Raf.	X	X		X	X
Potamogeton foliosus Raf.	X				X
Potamogeton freisii Rupr.		X			
Potamogeton gramineus L.			X		
Potamogeton natans L.					X
Potamogeton obtusifolius Mert. & Koch.	X				
Potamogeton pusillus L.					X
Potamogeton richardsonii (Benn.) Rydb.		X			X
Potamogeton robbinsii Oakes.	X	X	X	X	X
Potamogeton spirillus Tuckerm.					X
Potamogeton strictifolius Benn.		X			
Potamogeton zosteriformis Fern.					X
Ranunculus tricophyllus Chaix.	X	X			X
Sagittaria sp.		X	X		X
Scirpus cyperinus (L.) Kunth.				X	X
Scirpus validus Vahl.					X
Sium suave Walt.			X		
Typha spp.	X	X	X	X	X
Utricularia vulgaris L.			X		X
Vallisneria americana Michx.		X	X		X
Charophytes					
Chara sp.	X	X	X		
Total Number of Species	9	17	17	11	30

* indicates the species was not observed in 1981

TABLE 10

WILDLIFE UTILIZATION[1] OF THE EIGHT NEW SPECIES OBSERVED IN THE ATIKOKAN STUDY LAKES IN 1982

Calamagrostis canadensis	- young sprouts eaten by moose
Dulichium arundinaceum	- slight importance for wildfowl as muskrat food
Hippuris vulgaris	- seeds and sometimes foliage are eaten by wildfowl
Lemna sp	- important foot for some wildfowl, pheasant and beaver
Potamogeton alpinus	- food for ducks
P. foliosus	- important food for wildfowl
P. friesii	- food for ducks
P. obtusifolius	- slight food value for ducks

[1] based of Fassett (1957)

Distribution and Abundance

The vegetation in the selected bays is described in terms of the zonal pattern which is usually present in temperate lakes. Three zones associated with changes in water depth are generally recognized, but all are not necessarily present in every lake. These zones include a zone of emergent species in shallow water near shore, a zone of floating leafed species in deep water and a zone of submergent species in deeper water still (Curtis 1959).

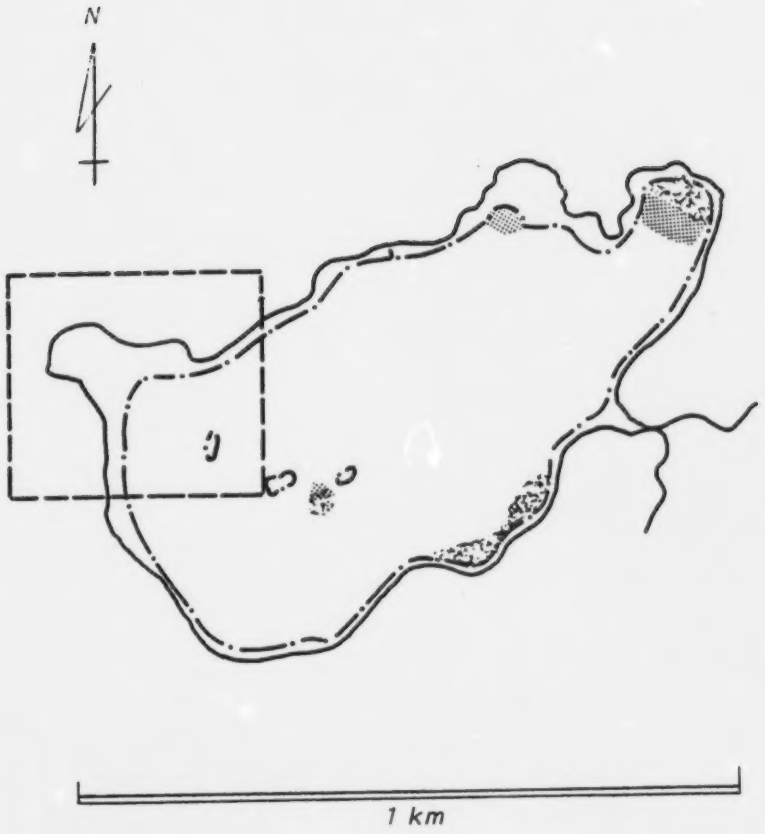
Snow Lake

Of the four sampling areas surveyed in both 1981 and 1982, the bay in Snow Lake exhibited the greatest change in species composition. This is largely the result of the lowering of the water level and the exposure of new substrate for plant colonization. Field observations suggested that the shoreline in July 1982 generally coincided with the 416 m elevation above sea level. Areas where discrepancies arose between the shoreline

and the 416 m depth contour were visually approximated and used to draw the shoreline in Figure 9, which shows the distribution of macrophytes. The area dominated by emergents consisted of recently exposed sediment which was being colonized by cattails (*Typha* spp). The total cover was 10 to 15%, but is likely to increase rapidly if the substrate remains exposed. A closed community of cattails, a mixed emergent community or an upland community of shrubs and trees could eventually develop depending on soil moisture conditions (Harris and Marshall 1963, Van der Valk and Davis 1980). The area was previously vegetated by submergents including *Lobelia dortmanna* (water lobelia), *Eriocaulon septangulare* (pipewort) and *Sparganium fluctuans* (bur reed), none of which were observed during the 1982 survey. These three species are soft water species which were unique to this location in the 1981 survey.

Although most of the area dominated by submergent species in 1982 was not vegetated in 1981, the total cover in 1982 was generally in the range of 50 to 100%. The major exception was in peripheral areas where the cover dropped rapidly over a distance of a few meters. The maximum depth at which vegetation was observed was 2 m.

The submergent species found on the four transects are listed in Table 11. The most abundant species were *Elodea canadensis* (waterweed), *Potamogeton foliosus* (a pondweed) and *Najas flexilis* (bushy pondweed). Four of the species present in 1982 were also present in 1981, but there were an additional nine submergents in this bay in 1981 not found in 1982 (Ontario Hydro Research Division Report No 83-338-K). Generally, there was little consistency in the number of species present, in the species associations or in the depth distribution of species among the four transects. For example, *Najas flexilis*, one of the more abundant species, was observed at all vegetated depths within the bay, but on the second transect was confined to water less than 1 m deep while on the fourth, it occurred only between the 1.6 m and 2 m depths. It occurred as a codominant with *Potamogeton foliosus* and in species mixtures with up to five other species. The spatial heterogeneity is possibly a consequence of the recent disturbance which allowed remnants of the previous submergent community to coexist with new colonizers. Disturbance is a factor contributing to spatial heterogeneity in terrestrial plant communities (Daubenmire 1968) and in some marsh communities (Van der Valk and Davis 1980).



—·— *Shoreline in 1982*

—— *Shoreline in 1981*

– – *Area Selected for Detailed Study*

Elodea canadensis Patches

Submergents Present

FIGURE 9

MACROPHYTE DISTRIBUTION IN SNOW LAKE OUTSIDE
THE AREA SELECTED FOR DETAILED STUDY

TABLE 11

MACROPHYTE SPECIES PRESENT ALONG THE TRANSECTS IN SNOW LAKE

Transect	1	2	3	4
Elodea canadensis	X	X	X	X
Najas flexilis		X	X	X
Potamogeton epihydrus			X	
P. foliosus	X	X	X	X
P. obtusifolius	X	X		
P. robbinsii	X	X		
Ranunculus tricophyllus		X		
Typha sp.		X		
Chara sp.		X		

Elodea canadensis and *Chara* sp (stonewort) were the only species with fairly distinct distribution patterns. *Chara* sp was observed only in shallow water less than 10 m from shore and was mixed with *Najas flexilis, Ranunculus tricophyllus* (water crowfoot) and the pondweeds, *Potamogeton robbinsii, P. foliosus* and *P. obtusifolius*. *Elodea canadensis* occurred only in water less than 1.6 m deep both at the lake margin and the edge of the island and formed either pure patches or was mixed with *Potamogeton foliosus* or *Najas flexilis*.

Visual observations revealed that most of the exposed shoreline on the south and east shores consisted primarily of bedrock or boulders. There was no vegetation along these shores except in two small bays where there were patches of *Elodea canadensis* (Figure 10). There were two bays on the northeast shore with vegetation. Cover in the most westerly of the two was sparse (<5%) with *Typha* sp colonizing the exposed substrate and *Potamogeton robbinsii* dominating the submergents. The exposed shore in the adjacent bay was bare and consisted of small rocks about 10 cm in diameter. The submergents were fairly dense and included *Myriophyllum exalbescens, Potamogeton robbinsii, Elodea canadensis* and *Najas flexilis*. *Potamogeton natans, P. amplifolius* and *Elodea canadensis* occurred between the two islands in the middle of Snow Lake.

Icy Lake

There were two bays surveyed on Icy Lake in 1982, one on the west shore and the other on the east.

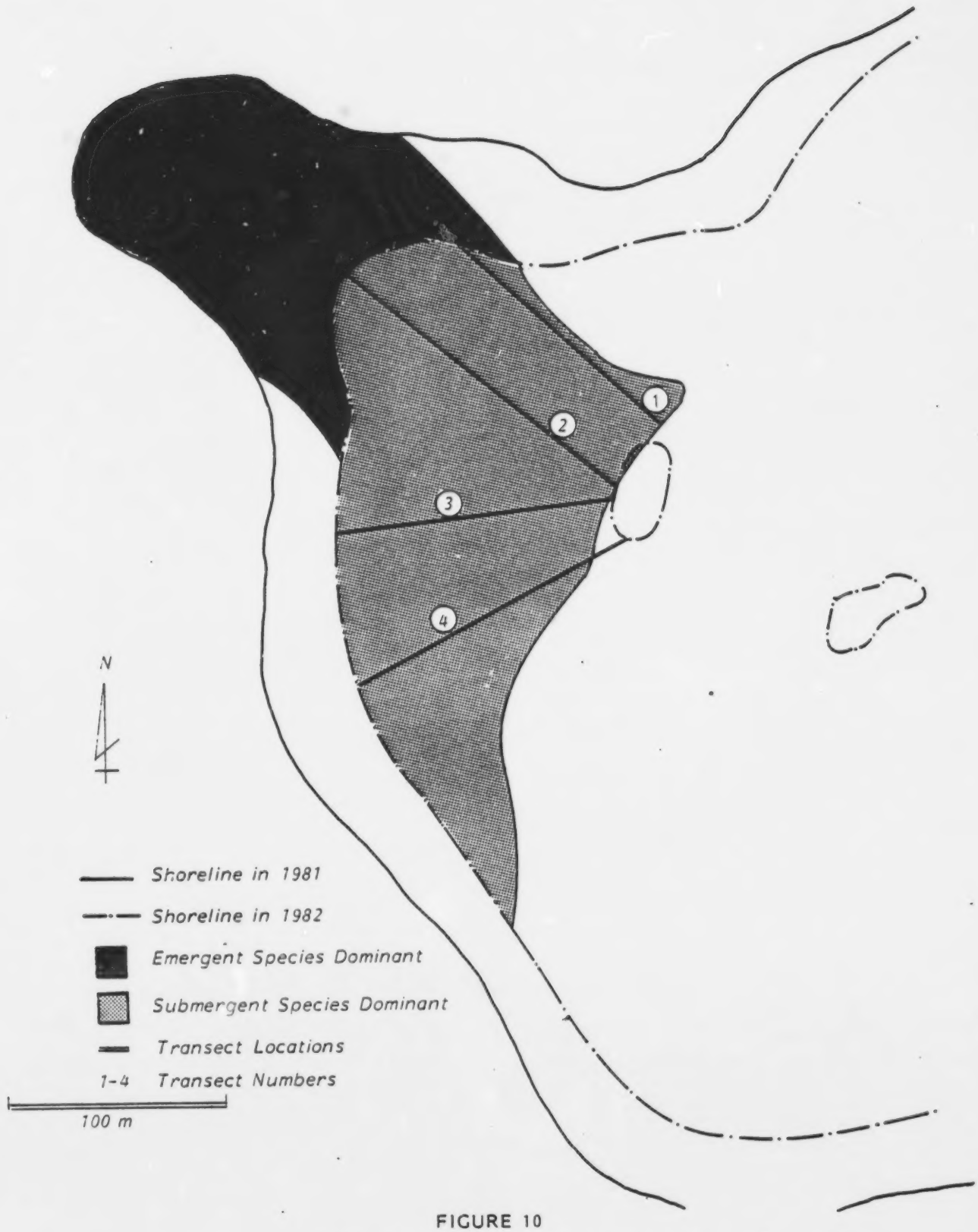


FIGURE 10

MACROPHYTE DISTRIBUTION ALONG THE WESTERN SHORE OF SNOW LAKE

161290 RD

The West Bay

A map showing the distribution of macrophytes in the west bay is shown in Figure 11. The species present are listed in Table 12. The emergent vegetation consisted of an intermittent band of cattails up to 3 m wide. The floating leafed species occurred in shallow water less than 20 cm deep and consisted of patchily distributed *Nymphaea odorata* (white water lily) which lacked an understorey. The composition of the submergent vegetation was spatially fairly uniform except at the mouth of the stream joining Snow Lake where construction activity had produced very turbid water. The water depth was less than 1 m throughout most of the northeastern arm and part of the southwestern arm and the bottom cover was generally in the range of 75 to 100% in the areas vegetated with submergents. *Potamogeton robbinsii* was the dominant species occurring either alone or with small amounts of *Najas flexilis, Elodea canadensis Chara* sp, *Potamogeton richardsonii* and *P. strictifolius*. There were occasional patches consisting entirely of *Chara* sp, but this shallow water cover type was relatively rare. In deeper water (<1 m, primarily in the central portions of the bay), *Myriophyllum exalbescens* was generally dominant occurring in mixtures with *Potamogeton robbinsii, P. friesii, P. strictifolius, P. epihydrus* and *Ranunculus tricophyllus*. Cover was generally lower than in the shallow areas, averaging 30 to 40%. In the vicinity of the construction activity there was 100% bottom cover consisting of a mixture of species including Callitriche hermaphroditica (water starwort), *Potamogeton friesii, P. strictifolius, Myriophyllum alterniflorum* (water milfoil), *Najas flexilis, Elodea canadensis, Ranunculus tricophyllus, Sagittaria* sp (arrowhead) and *Nymphaea odorata*. Overall, the vegetation in the west bay has changed little since 1981.

The East Bay

A map showing the distribution of macrophytes in the east bay in Icy Lake is shown in Figure 12. The species present are listed in Table 13. The water depth was less than 1.5 m throughout the bay except near the mouth where it dropped rapidly to 4 m. The maximum depth at which vegetation was observed was 2.2 m. Emergents were found in only two areas along the shore. At the northeast end *Typha* sp was mixed with shrubs in a band about 5 m wide, while on the south shore *Equisetum* sp and *Typha* sp were interspersed with *Nymphaea odorata* in a band about 8 m wide. *Nymphaea odorata*, a floating leafed species, was observed at several locations along the bay, but was never the dominant vegetation. The submergent species exhibited a distinct spatial pattern in the per cent bottom cover. A very dense band of macrophytes extended through most of the centre of the bay. The

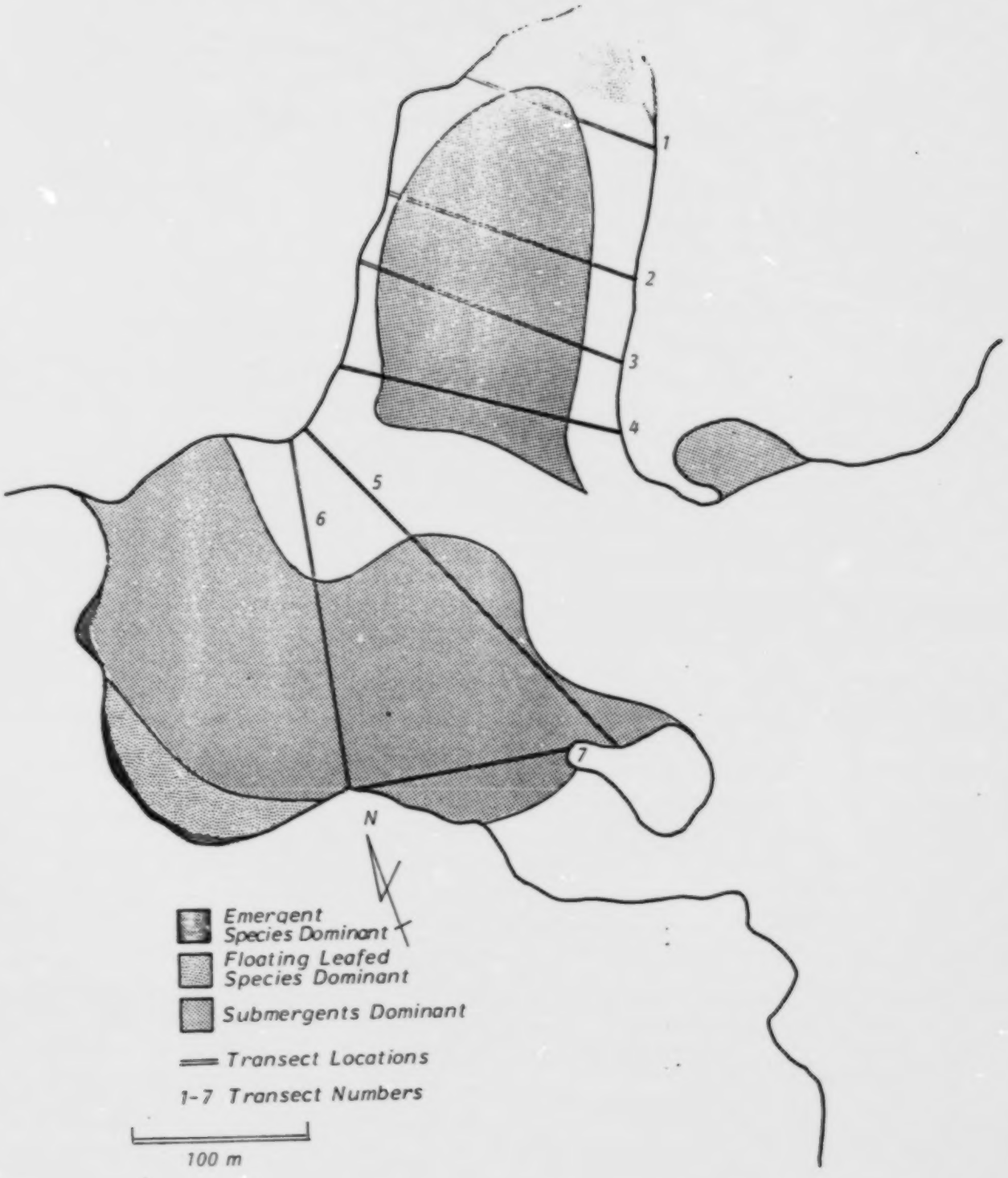


FIGURE 11

MACROPHYTE DISTRIBUTION IN THE WEST BAY OF ICY LAKE

84-54

161288 MD

TABLE 12

SUBMERGENTS PRESENT ALONG THE TRANSECTS
IN THE WEST BAY OF ICY LAKE

Transect	1	2	3	4	5	6	7
Chara sp		X	X	X			
Elodea canadensis		X	X				
Myriophyllum exalbescens				X	X		X
Najas flexilis		X	X				
Potamogeton epihydrus					X		
Potamogeton friesii				X	X		
Potamogeton richardsonii		X	X				
Potamogeton robbinsii	X	X	X	X		X	X
Potamogeton strictifolius		X	X		X		
Ranunculus tricophyllus				X			

TABLE 13

MACROPHYTES PRESENT IN THE EAST BAY OF ICY LAKE

Transect	8	9	10	11	12	13	14	15
Chara sp.					X		X	
Myriophyllum exalbescens					X	X	X	X
Najas flexilis	X	X	X		X			
Nymphaea odorata	X		X		X			
Potamogeton richardsonii		X						
Potamogeton robbinsii		X	X	X	X	X	X	X
Potamogeton strictifolius	X				X			
Vallisneria americana							X	

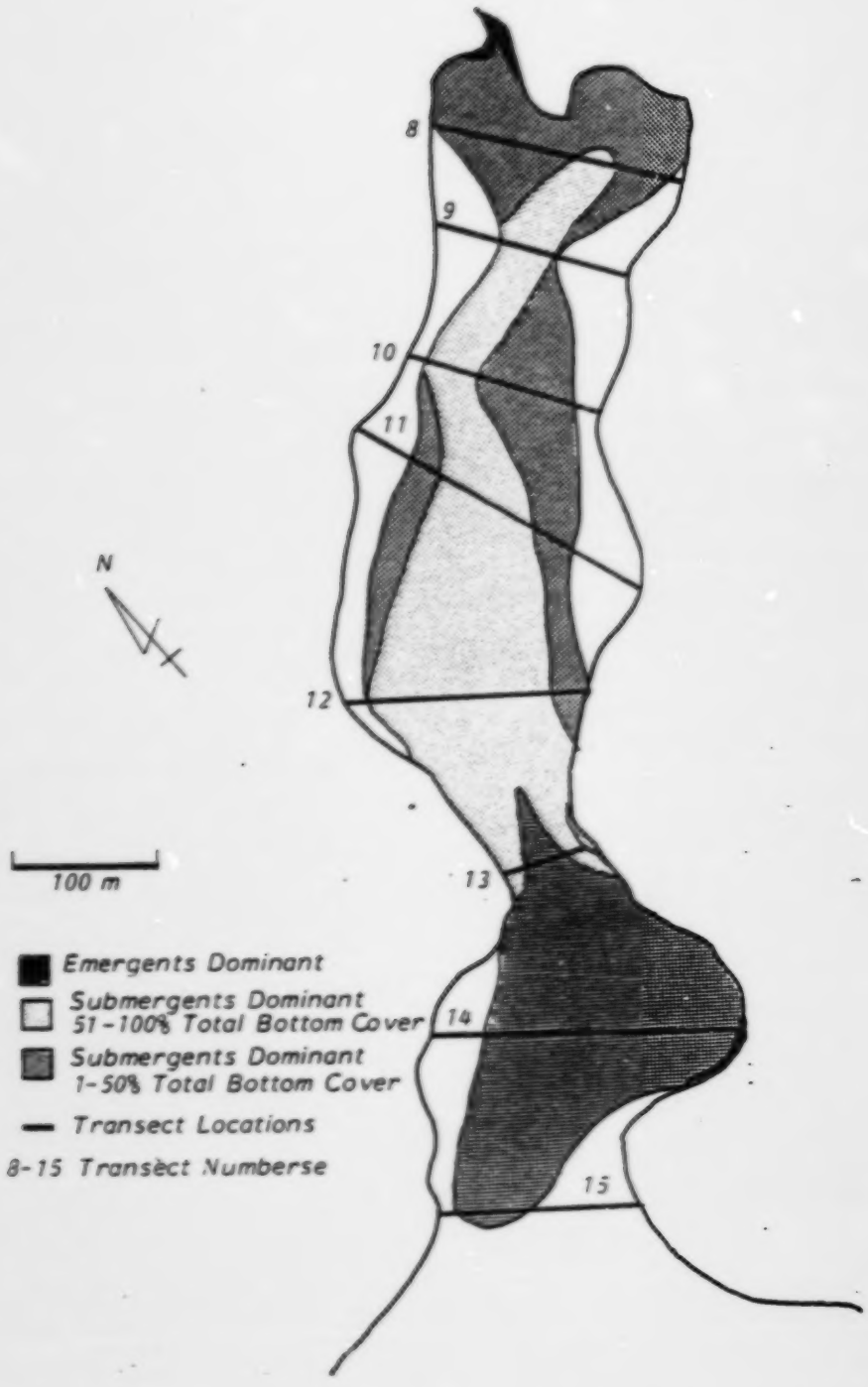


FIGURE 12

MACROPHYTE DISTRIBUTION IN THE
EAST BAY OF ICY LAKE

161205 RD

band approximately coincided with the distribution of the unconsolidated fine sediments determined from the substrate survey in 1981. Areas with no vegetation in the 1982 survey had predominately either bedrock or boulder cobble substrates. The two dominant submergent vegetation types in the dense band were a *Najas flexilis* community which had traces of one or more of the following *Potamogeton robbinsii*, *P. richardsonii*, *P. strictifolius* and *Nymphaea odorata*, and a *Potamogeton robbinsii* community with small amounts of one or more of *P. strictifolius*, *Najas flexilis*, *Chara* sp and *Myriophyllum exalbescens*. These two cover types were also present in the low cover areas, where there was also a third cover type dominated by *Myriophyllum exalbescens* mixed with *Vallisneria americana* (wild celery), *Potamogeton richardsonii* and *P. robbinsii*. The vegetation in this bay was similar to that observed in 1981, with one exception. In 1981 the sides of the bay were lined with an extensive bed of *Potamogeton strictifolius* and *Elodea canadensis*. *E. canadensis* was not observed at all in this bay in 1982 and *P. strictifolius* was present only as a minor component of some communities. The reason for the change is not definitely known, but it may be related to a change in flow conditions resulting from the widening of the stream that joins Icy Lake to Abie Lake.

Abie Lake

One bay was surveyed on Abie Lake. The species present are listed in Table 14 and macrophyte distribution is mapped in Figure 13. Vegetation was present throughout most of the bay, except on the east shore in the area where Abie Lake joins Marmion Lake. The substrate in this area was dominated by boulders. Overall, the vegetation was characterized by a well developed zonal pattern which was spatially, fairly uniform. Only small variations in the species present, the sequence of vegetation zones and their depth distribution were detected among the transects.

In the first zone a band of emergents ranging from 1 to 70 m wide lined the shore on all four transects. *Typha* sp was dominant. It was mixed with occasional *Sium suave* (water parsnip), *Sagittaria* sp (arrowhead) and *Dulichium arundinaceum* (three way sedge). The maximum depth recorded at the outer edge of the *Typha* zone was 1.1 m.

The second zone, a mixture of submergents, emergents and floating-leafed species, along Transects 2, 3 and 4 extended to a depth of 2.2 m. Total bottom cover ranged from 25 to 100% and consisted of a mixture of species. The most common species in this zone were *Nymphaea odorata*, *Najas flexilis*, *Chara* sp, *Vallisneria americana*, *Myriophyllum exalbescens* and *Potamogeton*

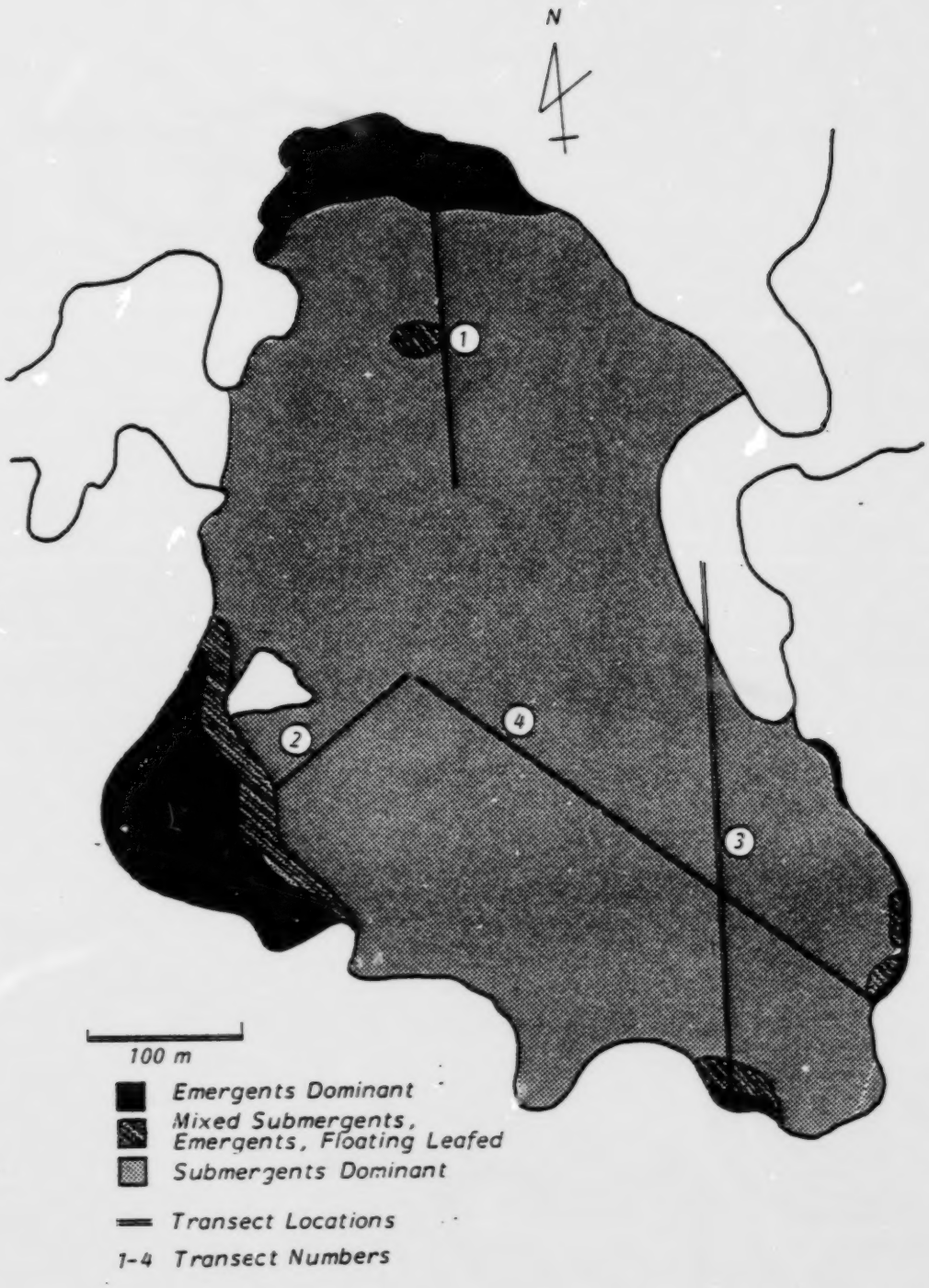


FIGURE 13

MACROPHYTE DISTRIBUTION IN THE EAST BASIN OF ABIE LAKE

161289 RD

gramineus. Other species present included *Glyceria borealis*, *Eleocharis acicularis*, *Sagittaria* sp, *Utricularia vulgaris*, and *Polygonum natans*. This zone was third in the sequence from the shoreline to deeper water along Transect 1.

TABLE 14

MACROPHYTE SPECIES PRESENT ALONG THE TRANSECTS IN ABIE LAKE

Transect	1	2	3	4
Brasenia schreberi	X			X
Chara sp.	X			
Dulichium arundinaceum		X		
Eleocharis acicularis		X		
Glyceria borealis	X		X	
Myriophyllum exabelscens	X	X		
Najas flexilis	X	X		X
Nymphaea odorata	X	X	X	
Polygonum natans	X	X		
Potamogeton gramineus		X		
Potamogeton robbinsii	X		X	X
Sagittaria sp.	X	X	X	
Sium suave	X	X		
Typha sp.	X	X	X	X
Utricularia vulgaris		X		
Vallisneria americana		X		

The submergent zone consisted of two distinct community types. Along Transects 3 and 4 one submergent community was dominated by a *Potamogeton robbinsii* weedbed which was generally quite dense, approaching 100% bottom cover throughout much of the area. This cover type was not observed on the second transect and was the second zone in the sequence from the shoreline to deeper water on the first transect. The water depth in the weedbed ranged from 1.5 to 2 m. This is deeper than the range (0 to 1 m) in Icy Lake where *Potamogeton robbinsii* was also prominent, but is within the 0 to 3 m range reported by Riley (1979) to be typical of this species. The second community which was the last zone on all transects was dominated by *Najas flexilis* which was mixed with occasional stems or patches of *Myriophyllum exalbescens*, *Brasenia schreberi* (water shield) and *Chara* sp. This community was the only one not documented during the 1981 survey when it may have been missed due to the low cover it reaches at the immediate boundary of the *Potamogeton robbinsii* zone. In the deeper areas (>2 m) *Najas flexilis* ranged in cover from 50 to 100%.

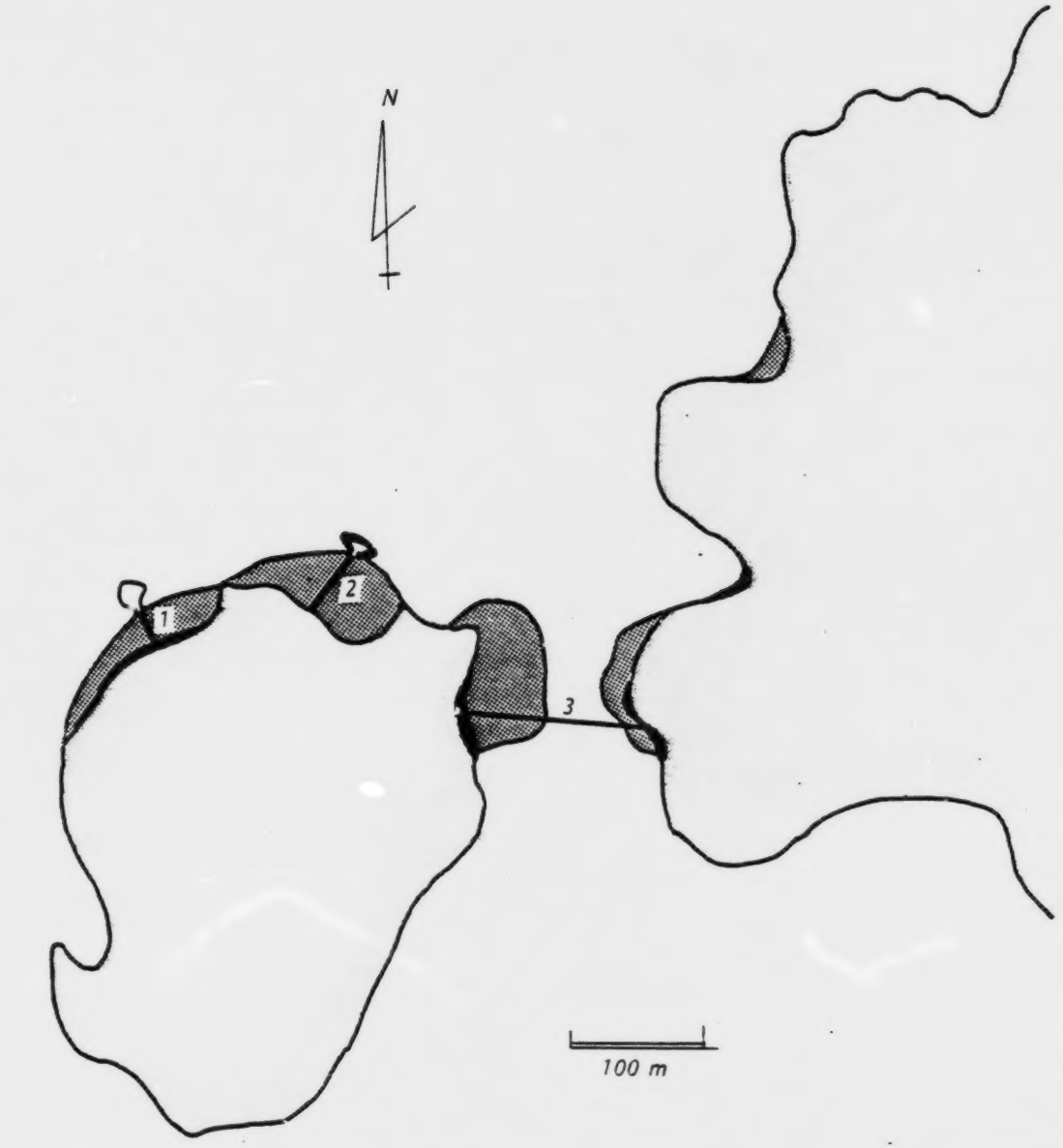
Marmion Lake

There were two areas surveyed on Marmion Lake in 1982, one near Abie Lake and the second near the Anderson Dam.

Near Abie Lake

This area was not surveyed in 1981. The species present in 1982 are listed in Table 15 and the vegetation is mapped in Figure 14. *Flyceria borealis* was the dominant emergent, except in the bay northeast of Transect 3 where *Scirpus* sp was intermixed with shrubs. There were three main submergent cover types. The first type was dominated by *Potamogeton zosteriformis* and *Myriophyllum exabelscens*. Other species present included *Potamogeton richardsonii, P. spirillus, P. amplifolius, Ranunculus tricophyllus* and *Callitriche hermaphroditica*. This community was prominent on the first transect where it formed 100% bottom cover up to 10 m from shore (3 m deep). At this point the cover dropped to 5 to 10% and eventually declined to 1% cover 30 m from shore. It was also prominent along the third transect where it formed 100% bottom cover and was present up to 30 m off the shore of the island. The second submergent cover type was dominated by *Potamogeton richardsonii* which occurred either alone or in mixture with other species. This cover type was prominent along the third transect offshore of the mainland where there was 100% bottom cover made up entirely of *P. richardsonii*. It was also present from 3.5 to 7 m offshore of the island along the third transect and from 0 to 15 m offshore of the large island on the second transect. In both of these areas it was mixed with several of the following species: *Myriophyllum exalbescens, M. alterniflorum, Potamogeton zosteriformis, P. spirillus, Najas flexilis, Elodea canadensis and Eleocharis acicularis*. The total bottom cover ranged from 70 to 100%. The remaining cover type occurred on the second transect offshore of the small island and was dominated by *Ranunculus tricophyllus* which was mixed with small quantities of *Myriophyllum exalbescens, Najas flexilis, Potamogeton spirillus* and *P. zosteriformis*. Most of the latter species were also components of the other two submergent community types. The maximum depth at which vegetation was observed was 3.5 m.

Potamogeton alpinus, a pondweed, was observed east of the second transect. This species was not collected from any of the areas surveyed in 1981, but was present in Marmion, Snow and Abie Lakes in 1976 (Acres 1976). The species is characteristically found in cold lakes (Riley 1979) on substrate with a high organic content (>20%) and a high iron to calcium ratio (Misra 1938).



Emergent Species Dominant

Submergent Species Dominant

Transect Locations

1-3 Transect Numbers

FIGURE 14

MACROPHYTE DISTRIBUTION IN MARMION LAKE NEAR ABIE LAKE

1612S4 RD

TABLE 15

MACROPHYTE PRESENT IN MARMION LAKE NEAR ABIE LAKE

Transect	1	2	3
Callitriche hermaphroditica	X		
Eleocharis acicularis			X
Elodea canadensis			X
Glyceria borealis	X	X	X
Myriophyllum alterniflorum		X	
Myriophyllum exalbescens	X	X	X
Najas flexilis		X	X
Potamogeton amplifolius	X		
Potamogeton richardsonii	X	X	X
Potamogeton spirillus	X	X	
Potamogeton zosteriformis	X	X	X
Ranunculus tricophyllus	X	X	
Sagittaria sp.			X

Anderson Dam

The species present in the vicinity of the Anderson Dam are listed in Table 16 and the vegetation is mapped in Figure 15. The areas covered by submergents were densely vegetated (100% bottom cover) except at the margins where the cover dropped rapidly over a short distance. The maximum depth at which vegetation was found was 3.5 m, but on some transects there were areas less than 3.5 m deep with no vegetation. Emergent vegetation was generally lacking, although there were a few isolated stems of *Sagittaria* sp and small patches of *Glyceria borealis* along the shore between Transects 1 and 3. A narrow band (1 to 2 m) of *Eleocharis* sp and *Typha* sp lined the shore at the point near the fourth transect.

Overall, *Potamogeton zosteriformis* and *Myriophyllum exalbescens* were the most abundant submergent species in the area between Transects 1 and 3, but they were not codominant in all parts of the area. *P. zosteriformis* was present on the first transect, but was less abundant than *Ranunculus tricophyllus* which formed either pure patches or was codominant with *Myriophyllum exalbescens*. Along the third transect *Ceratophyllum demersum* (coontail) was prominent forming a mixed community with *Myriophyllum exalbescens* and *Potamogeton zosteriformis*. Two other species which were locally abundant were *Callitriche hermaphroditica* and *Najas flexilis*. *Potamogeton richardsonii* was also present, but was uncommon.

FIGURE 15

MACROPHYTE DISTRIBUTION IN MARMION LAKE NEAR THE ANDERSON DAM

161283 RD

TABLE 16

MACROPHYTES PRESENT IN THE VICINITY OF THE ANDERSON DAM. MARMION LAKE

Transect	1	2	3	4
Callitriche hermaphroditica	X		X	
Ceratophyllum demersum			X	X
Eleocharis acicularis				X
Eleocharis sp.				X
Glyceria borealis	X			
Myriophyllum exalbescens	X	X	X	X
Najas flexilis	X	X	X	X
Potamogeton richardsonii		X		X
Potamogeton zosteriformis	X	X	X	X
Ranunculus tricophyllus	X			X
Sagittaria sp.	X		X	X
Typha sp.				X

The submergent vegetation in the vicinity of the fourth transect was patchily distributed. An extensive bed of *Ranunculus tricophyllus*, a carpet of *Eleocharis acicularis* and a *Potomogeton zosteriformis-Myriophyllum exalbescens* community occupied much of the area. Sagittaria sp were common. *Najas flexilis, Ceratophyllum demersum* and *Potamogeton richardsonii* were present.

Potamogeton zosteriformis, P. richardsonii and *Sagittaria* sp were abundant around the islands in the middle of the bay.

The association between Potamogeton zosteriformis and Myriophyllum exalbescens present at the Anderson Dam is similar to that observed at the area surveyed on Marmion Lake near Abie Lake, but in that area more species were present than at the Anderson Dam.

Slush Lake

Vegetation was absent from the area selected for survey on Slush Lake. A cruise of the entire shoreline revealed that aquatic vegetation was sparse throughout the entire area, except for a bay in the northwest which was dominated by emergents including *Glyceria grandis, Scirpus cyperinus, Typha* sp and *Hippuris vulgaris* (mare's tail) (Figure 16). There were small patches of *Nymphaea odorata* and *Potamogeton epihydrus* in a few areas along the shore. The two bays along the east shore which were the

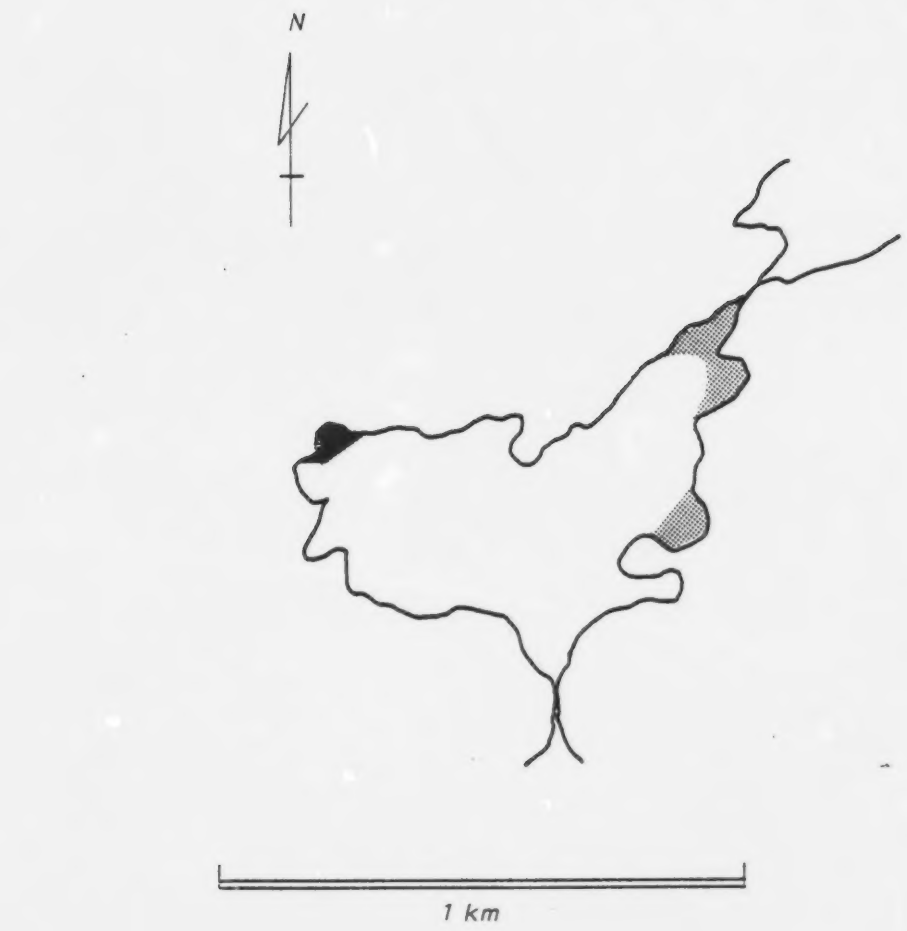


FIGURE 16
MACROPHYTE DISTRIBUTION IN SLUSH LAKE - 1982

161286 RD

most densely vegetated in 1981 were found to contain similar species as in 1981, but at an extremely low (5 to 10%) overall cover. The reason for the reduced cover in 1982 is unknown.

Vegetation Assessment

The vegetation within the selected areas generally exhibited the zonal pattern which is considered typical of temperate lakes (Curtis 1959). Overall the submerged species were the most abundant. The most common emergent was *Typha* sp which was present in every lake and which tended to form solid stands with few other species present. The tendency of *Typha* sp to form solid stands is characteristic of the species and has been attributed to its capacity for vigorous vegetative reproduction under favourable conditions (Linde et al 1976). Floating leafed vegetation in the study areas consisted primarily of white and yellow water lilies (*Nymphaea odorata* and *Nuphar* sp) which occurred either alone or with an understorey of submergents. There were four main recurrent submergent communities, recognized on the basis of their dominant species. These were a *Potamogeton robbinsii* community, a *Najas flexilis* community, a *Myriophyllum exalbescens* community, and a community in which *Myriophyllum exalbescens* was codominant with *Potamogeton zosteriformis*. All communities were not present in every sampling location, but among those locations where a community occurred, there were variations in its depth distribution and secondary species complement. Such variations are not unexpected and reflect local variations in factors such as substrate, slope and exposure of the sites to wind and waves. Hutchinson (1975) stated that the four species which dominated the submergent vegetation in the study sites are ordinarily regarded as typical of mesotrophic or eutrophic conditions. He presents data on water chemistry (p 373-375) which suggest that these species are restricted to lakes that are generally more alkaline than the Atikokan study lakes. However, more recent data shows that at least three of the species (*Potamogeton robbinsii*, *P. zosteriformis* and *Najas flexilis*) occur over a much broader range than that reported by Hutchinson (Hellquist and Crow 1980). (The latter researchers do not discuss the distribution of *Myriophyllum exalbescens*.)

Areas where the submergent vegetation did not conform to the typical zonal pattern include the bay surveyed in Snow Lake and the area in Icy Lake near the mouth of the stream joining Snow Lake. Disturbance from either drawdown or construction activity is a factor which may have influenced the vegetation patterns in these areas. The disturbance in Icy Lake was localized over a small area and the patterns throughout most of the bay are typically zonal. The disturbance in Snow Lake, on the other hand, has affected the vegetation in the entire lake resulting

in the loss of some species and in the appearance of others not present in 1981. Similarly, widening of the stream joining Icy Lake to Abie Lake and the consequent lowering of water levels may have been responsible for the disappearance of *Elodea canadensis* and for the reduced abundance of *Potamogeton strictifolius* in the east bay of Icy Lake.

The final area with patchily distributed vegetation was on Marmion Lake in a small bay in the vicinity of the Anderson Dam. The area is similar to the west bay of Icy Lake in that the area occupied by patchily distributed vegetation is only a small part of the total vegetated area. The patchiness in this area may be related to substrate variability. According to Hutchinson (1975, p 467) one of the dominants in the area, *Ranunculus tricophyllus* is a sand plant, whereas, *Myriophyllum exalbescens*, another common species in the area is a mud plant. A third common species, *Potamogeton zosteriformis*, has been characterized by Moyle (1945) as a plant of soft organic soils.

The maximum depth at which vegetation was observed in 1982 was 3.5 m, although in some areas there was no vegetation at shallower depths. This is similar to the maximum depth of 3.3 m observed by Acres Consultants in 1976 in the study lakes. It is interesting that this depth is at the low end of the range of Secchi depths recorded in 1981 during the summer growing season. Maristo (1941, cited in Hutchinson (1975), p 414) observed an approximately linear relationship between Secchi depth transparency and the maximum depth of macrophyte growth in 27 Finnish Lakes. If this relationship were used, a Secchi depth reading of 4.5 m would result in a predicted lower limit of vegetation of approximately 3.5 m.

3.2.2 Phytoplankton

Phytoplankton samples were taken at Snow Lake, Icy Lake, Abie Lake, Slush Lake and at three Marmion Lake locations (Marmion South, Marmion North and Anderson Dam) in May, August and October. Complete data are presented in Appendix 4.

In terms of mean seasonal biomass, the Pyrrophyta (flagellates including dinoflagellates and cryptomonads) was the most important algal group present in the study area (Table 17). It was the main group present over the sampling period at all locations except Snow Lake and Marmion South, where it was the second most abundant group. The Baccilariophyta (diatoms) was the second most abundant group present at all locations except Snow Lake and Marmion South. The Cyanophyta (blue-green algae) was the main group present in Snow Lake and the diatoms were the main algae present at Marmion South. The dominance of blue-green algae in Snow Lake may be related to its low water levels in

TABLE 17

SPECIES COMPOSITION AND MEAN BIOMASS (mg/m^3) OF PHYTOPLANKTON COLLECTED IN THE ATIKOKAN GS STUDY AREA IN MAY, AUGUST AND OCTOBER OF 1982

	Snow Lake		Icy Lake		Akie Lake		Slush Lake		Marmion Lake					
									South Spar		North Spar		Anderson Dam	
	mg/m^3	%	mg/m^3	%	mg/m^3	%	mg/m^3	%	mg/m^3	%	mg/m^3	%	mg/m^3	%
Cyanophyta	327.5	41	82.1	18	64.3	13	37.2	10	49.9	11	26.4	8	49.0	10
Anabaena sp	261.7	33	14.3	3	6.1	1	7.4	2	18.2	4	10.0	3	10.0	2
Aphanizomenon flos-aquae	11.9	1	27.2	6	17.6	4	20.8	5	13.9	3	10.1	3	19.7	4
Chroococcus sp.	12.0	2	4.4	1	9.6	2			10.2	2			8.4	2
Lyngbya sp.					20.0	4								
Merismopedia sp.							2.1	<1						
Microcystis sp.	41.9	5	23.2	5	11.0	2	6.9	2	7.7	2	6.4	2	11.0	2
Oscillatoria sp.			13.0	3										
Chlorophyta	60.8	9	12.1	3	9.8	3	51.1	11	6.5	3	6.8	4	23.1	4
Ankistrodesmus falcatus	1.5	<1	1.0	<1	3.0	1	8.5	2	1.1	<1	1.5	<1	<0.1	<1
Closterium	15.3	2												
Crucigenia sp.	0.5													
Cosmarium							22.0	5						
Elakatothrix gelatinosa	5.3	1	2.3	1	2.3	<1	0.7	<1	1.0	<1	0.3	<1	0.7	<1
Golenkinia sp.											4.3	1		
Gloeocystis							11.7	3						
Lagerheimia sp.							0.4	<1						
Lagerheimia quadriseta							1.1	<1			0.2	<1		
Nocystis sp.	4.2	1	3.3	1			5.0	1	3.3	1				
Schroederia setigera	0.4	<1												
Scenedesmus bijuga	5.3	1	2.3	<1	1.3	<1	0.5	<1	1.1	<1	0.4	<1	1.3	<1
Selenastrum sp.													2.0	<1
Spondylosium sp.							1.3	<1						
Tetraedron sp.	28.5	4	3.2	1	3.2	1							19.0	4
Bacillariophyta	175.7	22	95.1	2.	131.1	28	125.3	31	206.8	43	101.6	33	224.2	42
Asterionella formosa							13.8	3						
Asterionella gracillima	33.7	4	2.1	<1			2.1	2	29.9	7	4.3	1	4.3	1
Cymbella sp.									6.7	1				
Fragilaria sp.					1.5	<1								
Fragilaria crotonensis			2.1	<1					6.4	1				
Synedra sp.	29.0	4	9.0	2	26.7	6	20.0	5	20.0	4	6.3	2	6.7	1
Tabellaria sp.			26.7	6	30.0	6	13.3	3	13.3	3	16.7	4		
Cyclotella sp.	23.9	3	8.4	2	22.3	5	18.3	4	37.3	8	24.8	9	42.0	8
Melosira sp.	10.1	1	10.1	2	42.7	9	54.4	13	66.1	14	12.0	4	16.3	3
Pennales (unidentified)	39.0	5	36.7	8	7.7	2	3.3	1	13.3	3	15.0	5	16.7	3
Rhizosolenia sp.	40.0	5							10.0	<2				
Stephanodiscus sp.									8.3	<1				
Stephanodiscus niagarae													138.3	26
Diatoma											22.5	8		
Unidentified sp.									3.3	1				
Chrysophyta	11.4	1	20.9	4	17.7	3	12.7	3	13.8	3	4.4	2	6.3	1
Dinobryon sp.	7.6	1	1.3	<1	6.3	1	5.7	1	2.5	1	1.0	<1	2.5	<1
Dinobryon sociale	3.8	<1	19.6	4	11.4	2	7.0	2	4.4	1	3.5	1	3.8	1
Mallomonas sp.									13.8	1				
Pyrrophyta	206.2	27	246.1	53	237.3	53	189	45	179.7	40	148.6	31	237.8	43
Cryptomonas sp.	28.0	4	38.4	8	15.1	3	61.0	15	41.1	9	37.5	13	31.7	6
Rhodomonas minuta	134.0	19	195.8	43	205.3	44	93.1	22	126.9	28	96.1	33	193.8	35
Unidentified Cryptophyta	24.2	3	13.9	3	16.9	4	18.3	4	11.7	3	15.0	5	10.3	2
Peridinium	11.1	1	4.4	1	11.1	2	16.6	4						
Mean Total Biomass	792.6		460.7		471.3		415.3		436.7		287.9		540.4	

1982. The blue-greens were more important than the green algae (Chlorophyta) at all locations except Slush Lake where they were of equal importance.

The flagellates,followed by the diatoms, were also found to be the most important algae present in the study area during the 1981 Atikokan preoperational study (Ontario Hydro Research Division Report No 83-338-K).

Schindler and Holmgren (1971) who studied the mid-summer phytoplankton of the ELA lakes in Northwestern Ontario found the Chrysophyta (golden algae) to be the largest algal group present in those lakes. In contrast, in our study area, the chrysophytes made up relatively small portions of the algal biomass. Schindler and Holmgren (1971) found the diatoms to be important only in some of their lakes while the flagellates were an important part of the algal biomass in all their lakes. Thus the phytoplankton of the ELA lakes and our study lakes were similar mainly in the importance of the flagellates and differed in the porportion of chrysophytes and diatoms. There is no readily apparent reason for this difference.

The flagellate *Rhodomonas minuta* was the main species present at all locations except Snow Lake where the blue-green algae *Anabaena* was the main contributor to algal biomass over the sampling season. The flagellate *Cryptomonas* was relatively abundant in all lakes. Other taxa found to be common and widespread were the blue-green algae *Aphanizomenon flos-aquae* and *Microcystis*, and the green algae *Ankistrodesmus falcatus*, *Elakatothrix gelatinosa* and *Scenedesmus bijuga*. Common diatoms included *Synedra*, *Cyclotella*, *Melosira*, and a group of unidentified pennales. The chrysophyte *Dinobyron* was found in low abundances at all locations.

The total number of taxa identified during the sampling season ranged between 20 at Marmion North and Anderson Dam to 26 in Slush Lake. Mean total phytoplankton biomass was low and ranged from 288 mg/m^3 at Marmion North to 793 mg/m^3 at Snow Lake and were intermediate at the remaining locations. Total phytoplankton biomass was highest in May at all locations except Anderson Dam where it was highest in October. Vollenweider (1968, in Vollenweider *et al* 1974) described the maximum phytoplankton biomass level as being below 1 000 mg/m^3 in highly eutrophic lakes. With the exception of the total phytoplankton biomass estimated for Snow Lake in August, all estimates were less than 1 000 mg/m^3. Thus by Vollenweider's classification scheme all the study lakes except Snow Lake were ultraoligotrophic.

R. minuta was the main taxa present at all locations in May. In August it was dominant at Slush Lake, Marmion North and Anderson

Dam, and was co-dominant with *Melosira* at Marmion South. At the remaining locations *Anabaena* dominated in August in Snow Lake, *Cryptomonas* in Icy Lake and *Tabellaria* and *Melosira* co-dominated in Abie Lake. In October *R. minuta* was the most important species present at Icy Lake, Marmion South and Snow Lake and was co-dominant with cryptomonads at Marmion North and Abie Lake. *Cryptomonas* was the main taxa present in October at Slush Lake.

With the exception of the flagellates, no consistent trends were observed in the seasonal biomass estimates (Figure 17) of the phytoplankton groups. In the case of the flagellates, highest biomass was estimated in May at all locations. At this time the flagellates were most abundant in Abie and Icy Lakes. These two lakes were found to have higher levels of nutrients than the remaining lakes. The blue-green algae were most abundant in August at all locations except Slush Lake and Anderson Dam. The biomass of the blue-greens were exceptionally high in Snow Lake at this time (905 mg/m^3).

3.2.3 Zooplankton

Complete zooplankton data are presented in Appendix 5.

Rotifers

May, August and September samples collected in Snow Lake, Icy Lake, Abie Lake, Slush Lake and at three Marmion Lake locations (Marmion South, Marmion North and Anderson Dam), indicated that *Keratella cochlearis*, *Polyarthra* and *Kellicottia longispina* were the main rotifers present in the study area. *Asplanchna* and *Gastropus* were also abundant while *Keratella quadrata*, *Filinia longiseta* and *Conochilus unicornis* were common and widespread.

K. cochlearis, *Polyarthra* and *Kellicottia longispina* were also the main rotifers present during the first year of the Atikokan preoperational study conducted in 1981 (Ontario Hydro Research Division Report No 83-338-K). Further the common forms identified in the present study were also common in 1981. Acres (1976) found *K. cochlearis*, *Asplanchna* and *Polyarthra* to be the dominant rotifers in the same study area in 1975-1976.

These three main rotifers were described by Pejler (1962, 1965) and Ruttner-Kolisko (1974) as dominant forms in oligotrophic lakes of the temperate zone while members of the genera *Asplanchna gastropus* and *Conochilus* were among the rotifers described as common in oligotrophic lakes. Thus the main rotifer taxa of our study lakes are typical of oligotrophic waters. Schindler and Noven (1971) noted that Pejler's (1962, 1965) observations fit their findings for the ELA lakes in Northwestern Ontario in 1968-1969. According to Ruttner-Kolisko

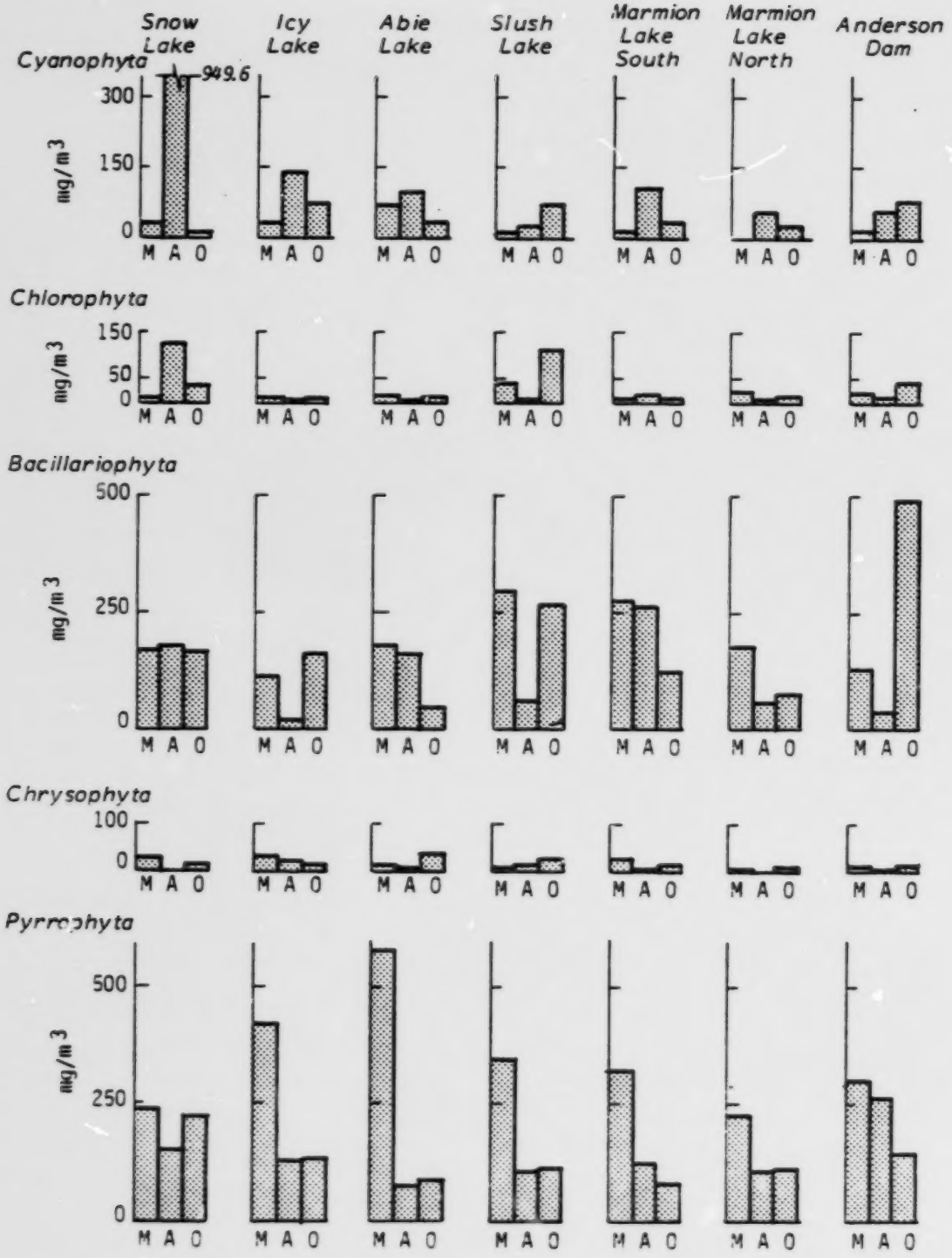


FIGURE 17
BIOMASS ($mg\ m^3$) OF PHYTOPLANKTON GROUPS IN THE ATIKOKAN GS STUDY AREA ON MAY (M), AUGUST (A), AND OCTOBER (O) OF 1982

(1974), *F. longiseta* and *K. quadrata* are usually present in eutrophic lakes of the temperate zone, although their distribution is not limited to these lakes. However, *K. quadrata* which was common in our study area in both 1981 and 1982 was not recorded for the ELA lakes (Schindler and Noven 1971).

The number of rotifer taxa identified at each location over the study period ranged from 15 at Snow Lake and Marmion South to 22 at Icy and Abie Lakes.

The mean relative abundances (Table 18) of the rotifers for the study period indicated that *K. cochlearis* was the most abundant rotifer present at all locations except Marmion North where its abundance was estimated to be just slightly lower than that of *Polyarthra*. *Polyarthra* was the second most prevalent taxa present at all of the remaining locations with the exception of Icy Lake where *K. longispina* was more abundant. Thus the rotifers of the lakes were similar in their dominance by *K. cochlearis* and *Polyarthra*.

The rotifer species composition in Icy Lake was most different from the other lakes in its high abundance of *Brachionus angularis*. This taxa was only found at one other location, Marmion North, where it occurred in low numbers. Brachionids were not found in the samples collected from Icy Lake in 1981 either (Ontario Hydro Research Division Report No 83-338-K). Members of the genus *Brachionus* was described by Nauwerck (1978) as having affinity for cold eutrophic waters. Icy lake was found to have higher levels of nutrients than most of the remaining lakes.

Higher numbers of rotifers were found in Snow, Icy and Abie Lakes than at the Marmion Lake locations and at Slush Lake where lowest numbers were estimated. Icy Lake was among the locations found to have higher abundances of rotifers in the 1981 study and Slush Lake was also estimated to contain the lowest numbers of rotifers in 1981. The mean total number of rotifers for the three sampling occasions were estimated at 72 616, 69 810, and 75 825/m^3 for Snow, Icy and Abie Lakes, respectively, 31 677, 40 597 and 59 574/m^3 at Marmion South, Marmion North and Anderson Dam, respectively, and 28 839/m^3 for Slush Lake.

K. cochlearis was the dominant rotifer present in Abie Lake and Snow Lake, and at Marmion South and Anderson Dam on all three sampling occasions. It was also the main rotifer present at the remaining three locations in October as well as in August in Slush lake. Its relative abundance ranged from 1% in the Icy Lake August sample to 74% in the October Slush Lake sample.

TABLE 16

SPECIES COMPOSITION AND MEAN DENSITIES (No m^{-3}) OF ROTIFERS IN LAKES INCLUDED IN THE ATIKOKAN GS PREOPERATIONAL STUDY - YEAR II, 1982

	Snow Lake		Icy Lake		Able Lake		Slush Lake		South Spar		North Spar		Anderson Dam	
	No m^{-3}	%	No m^{-3}	%	No m^{-3}	%	No m^{-3}	%	No m^{-3}	%	No m^{-3}	%	No m^{-3}	%
Trichotria tetractis					62	0.1								
Brachionus spp.			150	0.2	300	0.4	10	<0.1					150	0.3
Brachionus angularis					750	1.0								
Brachionus calyciflorus			9 072	13.0							23	0.1		
Keratella cochlearis	31 313	43.1	26 847	38.5	32 850	43.3	14 984	52.0	12 396	39.1	14 425	35.5	24 517	41.2
Keratella quadrata	322	0.4	1 140	1.6	705	0.9	626	2.2	185	0.6	278	0.7	308	0.5
Keratella taimalis			555	0.8	185	0.2	2 759	9.6			46	0.1	62	0.1
Kotholas aquamula					62	0.1	83	0.3			23	0.1		
Kotholas labis			62	0.1										
Kotholas foliacea			123	0.2			82	0.3						
Kellicottia longispina	10 849	14.9	10 825	15.5	1 650	2.2	2 425	8.4	3 105	9.8	2 640	6.5	5 482	9.2
Lepadella spp.	123	0.2							207	0.7				
Lecane spp.							82	0.3					75	0.1
Lecane lunaris	185	0.3	62	0.1	62	0.1	82	0.3	163	0.5	47	0.1		
Lecane luna					75	0.1								
Lecane bula													300	0.5
Trichocerca spp.	322	0.4									93	0.2	75	0.1
Trichocerca cylindrica			740	1.1	600	0.8			493	1.6	370	0.9	375	0.6
Trichocerca multicrinis					300	0.4								
Trichocerca porcellus									82	0.3	93	0.2	75	0.1
Trichocerca longiseta	568	0.8					165	0.6	82	0.3	23	0.1		
Asplanchna spp.	3 597	5.0	6 366	9.1	7 657	10.1	1 079	3.7	2 201	6.9	3 034	7.5	3 921	6.6
Asplanchna priodonta	1 296	1.8	370	0.5	987	1.3			432	1.4	324	0.8	555	0.9
Polyarthra spp.	13 079	18.0	6 021	8.6	11 509	15.2	4 839	16.8	7 009	22.1	14 912	36.7	15 593	26.2
Synchaeta spp.	922	1.3	273	0.4	2 606	3.4			514	1.6	302	0.7	785	1.3
Ploesoma triacanthum					150	0.2								
Ploesoma truncatum			62	0.1									150	0.3
Filinia longiseta	322	0.4	370	0.5	273	0.4	83	0.3	533	1.7	278	0.7	185	0.3
Conochilus spp.													450	0.8
Conochilus unicornis	785	1.1	2 010	2.9	1 950	2.6	370	1.3	698	2.2	510	1.3	750	1.3
Ascomorpha spp.			62	0.1	150	0.2								
Gastropus spp.	8 270	11.4	1 604	2.3	8 667	11.4	780	2.7	10 607	11.2	2 618	6.4	5 765	9.7
Trochosphaera					4 125	5.4	42	0.1						
Cephalodella gibba			2 400	3.4										
Conochiloides dossuarius	370	0.5	185	0.3			247	0.9			557	1.4		
Notarthra sire			450	0.6										
Unidentified rotifers	322	0.4	62	0.1	150	0.2	102	0.4	42	0.1				
Mean Total	72 616		69 810		75 825		28 839		31 677		40 597		59 574	

K. longispina (47%) was the main rotifer present in Icy Lake in May and *Brachionus* (55%) in August. In Slush Lake, *Keratella heimalis* was the dominant (47%) form present in May. At Marmion North *Polyarthra* was the most important rotifer present in May and August (51 and 48%, respectively).

Total rotifer abundance was higher in October than in May and August at all locations sampled with lowest total density in this month estimated for Marmion South (36 375/m^3) and highest for Abie Lake (112 275/m^3).

K. cochlearis and *Polyarthra* were most abundant in October at all locations sampled (Figure 18). This is consistent with the autumn density peak these taxa were found to have during the 1981 Atikokan preoperational study. With the exception of Anderson Dam, where it was most abundant in October, *Kellicottia longispina* was found in highest densities in either May or August. *Gastropus* was most abundant in October in all lakes except Abie and Icy, where it was more abundant in May and August, respectively.

Crustacean Zooplankton

The cyclopoid copepods were the most abundant crustacean zooplankton in all the study lakes with the exception of Snow Lake where the cladocerans were more prominent (Table 19). The cyclopoid copepods made up from 35% (Snow Lake) to 56% (Slush Lake) of the mean total abundances estimated for the lakes. The mean abundance of the cladocerans in Snow Lake was 41%.

The most important adult cyclopoid copepod form was *Diacyclops biscuspidatus thomasi*. *Mesocyclops edax* was the only other cyclopoid copepod species identified with the adults found in considerably lower abundances than *D. bicuspidatus thomasi* adults. Therefore most of the cyclopoid copepod nauplii and copepodites probably belonged to the latter species.

The calanoid copepods represented between 23% (Anderson Dam) and 31% (Abie Lake) of the mean total densities estimated for the seven locations. *Diaptomus oregonensis* adults were the only adult calanoid copepod form found in Slush Lake and at Marmion South, and was the most abundant adult form present at the remaining locations. *Diaptomus minutus* adults were found at all locations except Slush Lake and Marmion South. At the locations where it was found, *D. minutus* occurred in lower abundances than *D. oregonensis*. The only other calanoid copepod species found in the study area was *Diaptomus sicilis*, the adults of which were only found in low numbers at Marmion North.

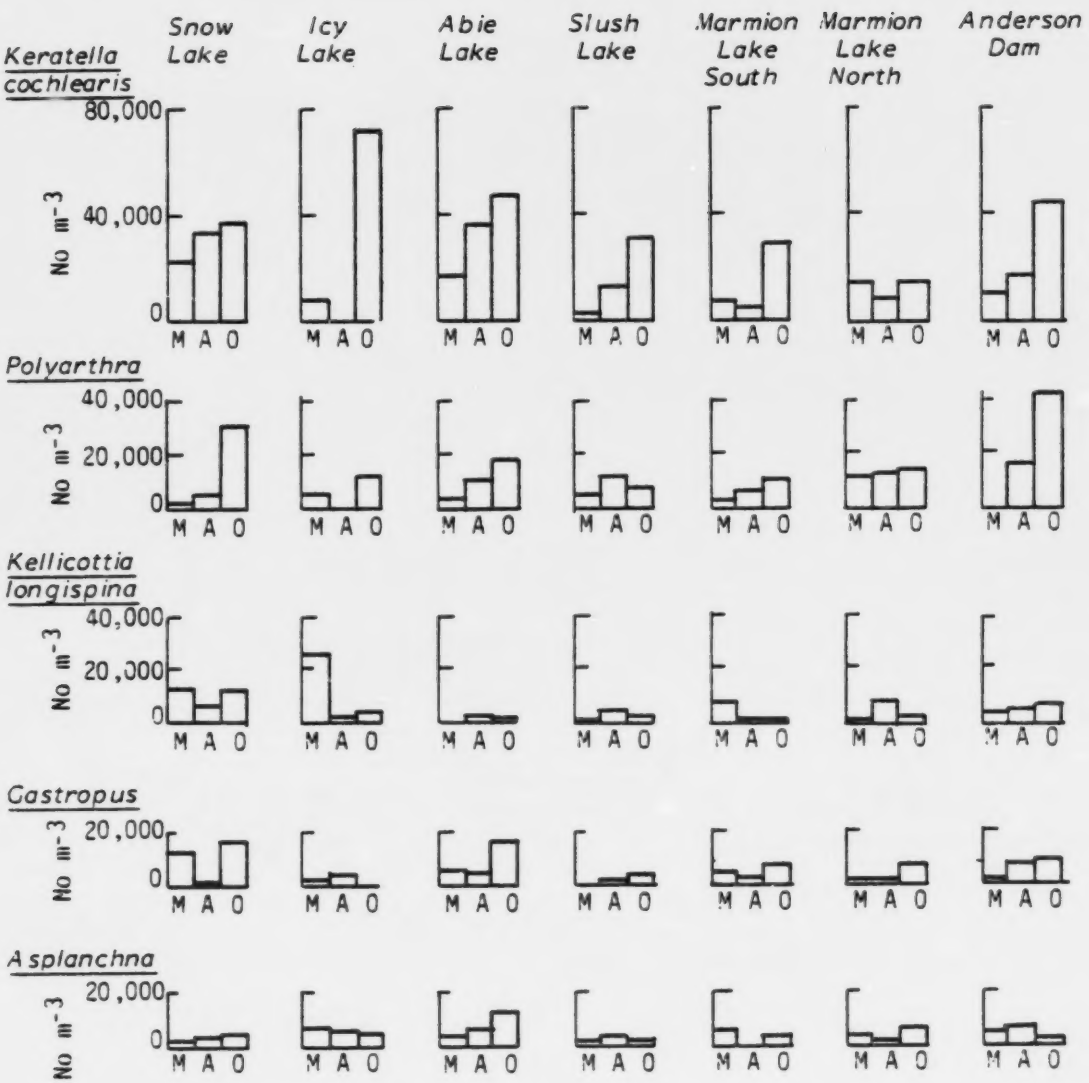


FIGURE 18

DENSITIES (NO m^{-3}) OF FIVE MAIN ROTIFERS FOUND IN THE ATIKOKAN GS STUDY AREA IN MAY (M), AUGUST (A) AND OCTOBER (O) OF 1982

TABLE 19

SPECIES COMPOSITION AND MEAN DENSITIES (No m^{-3}) OF CRUSTACEAN ZOOPLANKTON IN LAKES INCLUDED IN THE ATIKOKAN GS PREOPERATIONAL STUDY - YEAR 11, 1982

	Snow Lake		Icy Lake		Able Lake		Slush Lake		Harmon Lake					
									South		North		Anderson Dam	
	No m^{-3}	%	No m^{-3}	%	No m^{-3}	%	No m^{-3}	%	No m^{-3}	%	No m^{-3}	%	No m^{-3}	%
Cladocera														
Diaphanosoma leuchtenbergianum	767	2	555	3	150	<1	453	3	247	1	602	2	225	<1
Holopedium gibberum	247	1	62	<1	150	<1	492	3	1 150	4	1 205	5	1 050	2
Daphnia pulex			62	<1										
Daphnia longiremis			287	1	1 385	4			657	3	185	1	900	2
Daphnia retrocurva									370	1	325	1		
Daphnia galeatamentotae	150	<1												
Daphnia parrula	2 545	6	2 618	13	2 100	6	370	2	2 180	8	602	2	1 473	3
Daphnia spp			123	1	287	1			165	1				
Ceriodaphnia lacustris	1 887	4	273	1	975	3			163	1	210	1	1 637	3
Ceriodaphnia spp	75	<1	123	1					82	<1	3 212	12	7 746	16
Bosmina longirostris							82	<1						
Eubosmina coregoni	11 585	26	710	4	1 712	5	658	4	1 623	6	3 212	12	7 746	16
Chydorus sphaericus							82	<1	82	<1				
							165	1						
Copepods														
Diaptomus oregonensis (adults)	3 139	7	1 512	8	2 762	8	1 724	10	1 954	7	1 876	7	2 784	6
Diaptomus minutus (adults)	573	1	335	2	600	2					138	1	1 023	2
Diaptomus sicilis (adults)											185	1		
Calanoid copepodites (juveniles)	1 397	3	732	4	820	3	842	5	760	3	719	3	1 345	3
Calanoid nauplii (larvae)	7 124	16	2 508	13	6 029	18	2 610	15	3 577	14	3 520	13	5 426	12
Diacyclops bicuspidatus thomasi (adults)	3 576	8	2 587	13	3 406	10	1 809	10	2 242	9	2 155	8	5 074	11
Mesocyclops edax (adults)	670	1	560	3	582	2	370	2	597	2	532	2	723	2
Cyclopoid copepodites (juveniles)	3 046	7	2 081	11	1 989	6	2 280	13	2 714	10	1 946	7	5 631	12
Cyclopoid nauplii (larvae)	8 513	19	4 638	23	9 765	30	5 446	31	7 504	29	9 121	34	11 883	25
Total Number of Crustacean Zooplankton	45 293		19 766		32 710		17 382		26 067		26 625		47 071	

In the first year of the Atikokan preoperational study conducted in 1981, the cyclopoid copepod were the most abundant crustacean zooplankton in all lakes. As in the present study, *D. bicuspidatus thomasi* and *M. edax* were the only cyclopoid copepods identified with the former found in considerably higher abundances. The calanoid copepods identified in 1981 were similar to those found in this year with *D. oregonensis* also found to be the most abundant species. *D. sicilis* was also only found at a Marmion Lake location, Marmion Central. Schindler and Noven (1971) found either *D. bicuspidatus thomasi* or *D. minutus* to be the numerically dominant crustacean zooplankton in the 45 ELA lakes included in their study (1971). Acres (1976) found *D. bicuspidatus thomasi* to be the dominant cyclopoid copepod and *D. minutus* and *D. sicilis* to be the main calanoid copepods in the study area in 1975-1976.

Bosmina longirostris was the most abundant cladoceran present in Snow and Slush Lakes, and at Marmion North and Anderson Dam. *Daphnia galeata mendotae* was the main cladoceran found at the remaining locations (Icy Lake, Abie Lake, and Marmion South). Both cladocerans were present at all locations. Other cladocerans found to be common in the study area were *Diaphanasoma leuchtenbergianum* and *Holopedium gibberum*. *Daphnia longiremis* was present at all locations except Snow and Slush Lakes and *Ceriodaphnia lacustris* was present at all locations except Abie and Slush Lakes. Less common forms found were *Daphnia pulex, Daphnia retrocurva, Daphnia parvula, Eubosmina coregoni* and *Chydorus sphaericus*. The main cladocerans present in the study area in 1981 were also *B. longirostris* and *D. galeata mendotae*. With the exception of *Daphnia ambigua*, which was not found in the present study, the cladocerans found in 1981 were similar to those found in this study. Acres (1976) identified *B. longirostris, Diaphanosoma brachyurum, D. galeata mendotae, Chydorus* and *Ceriodaphnia* as the dominant cladocerans in the study area in 1975-1976. The common crustacean zooplankton found in the study lakes are all common and widespread in Ontario.

The number of crustacean zooplankton species found over the study period at each location was 10 at Snow Lake, Abie Lake, Slush Lake and Anderson Dam, and 12 at Icy Lake, Marmion South and Marmion North.

Higher numbers of crustacean zooplankton were found at Anderson Dam and Snow Lake than at the remaining locations while lower numbers were found at Slush and Icy Lakes. Lower densities of crustacean zooplankton were also found in Slush Lake during the 1981 study. The mean total densities of crustacean zooplankton for the three sampling occasions were estimated at 47 071 and 45 293/m^3 for Anderson Dam and Snow Lake, respectively, 32 710,

26 625 and 26 067/m^3 for Abie Lake, Marmion North and Marmion South, respectively. At Slush and Icy Lakes the mean total densities for the study period were 19 766 and 17 382/m^3, respectively. Highest total crustacean zooplankton abundances were estimated for August at all locations.

The cyclopoid copepods dominated the crustacean zooplankton at all locations in May. The calanoid copepods dominated in Abie Lake in August and October, in Snow Lake in August and in Slush Lake in October, while *B. longirostris* was numerically dominant at Anderson Dam and Slush Lake in October. The cyclopoid copepods were the main crustaceans present in August and October at the remaining locations.

No consistent trends were obvious in the seasonal density distributions of the cyclopoid and calanoid copepods (Figure 19) at the seven locations. However, the cyclopoid and calanoid nauplii were more abundant in August than in May and October at most locations. *B. longirostris* was more abundant in October than in May and August at all locations except Snow and Slush Lakes. This is consistent with the autumn population peak found for this species in the 1981 study.

3.2.4 Fish

Beach Seines

A total of 1902 fish representing 11 species were caught in beach seines during 1982 (Appendix 6). Blacknose (29.5%) and mimic shiner (20.1%) were the most common species (Table 20). Pumpkinseed were also relatively abundant (19.3%), however; the majority (354 of 367) were caught in Snow Lake. Only three and 14 fish were caught in beach seines at Marmion Central and Moose Lake, respectively. Of the remaining locations blacknose shiner was the most common species at Icy Lake, Marmion South and Marmion North, mimic shiner at Anderson Dam, pumpkinseed at Snow Lake, yellow perch at Lower Seine and yellow perch and Iowa darter at Abie Lake.

During 1981 blacknose shiner (29.8%), yellow perch (27.9%) and mimic shiner (20.9%) were the most common species caught in beach seines. With the exception of Marmion South and North and Snow Lake, the most common species in each basin in 1982 were also the most common or relatively common species in 1981. In 1981 yellow perch was the most common species at Marmion South and North and blacknose shiner was the most common species in Snow Lake. These differences probably reflect a temporal (seasonal) variability in the nearshore fish community as the fish were sampled at least monthly in 1981 and only on three occasions in 1982.

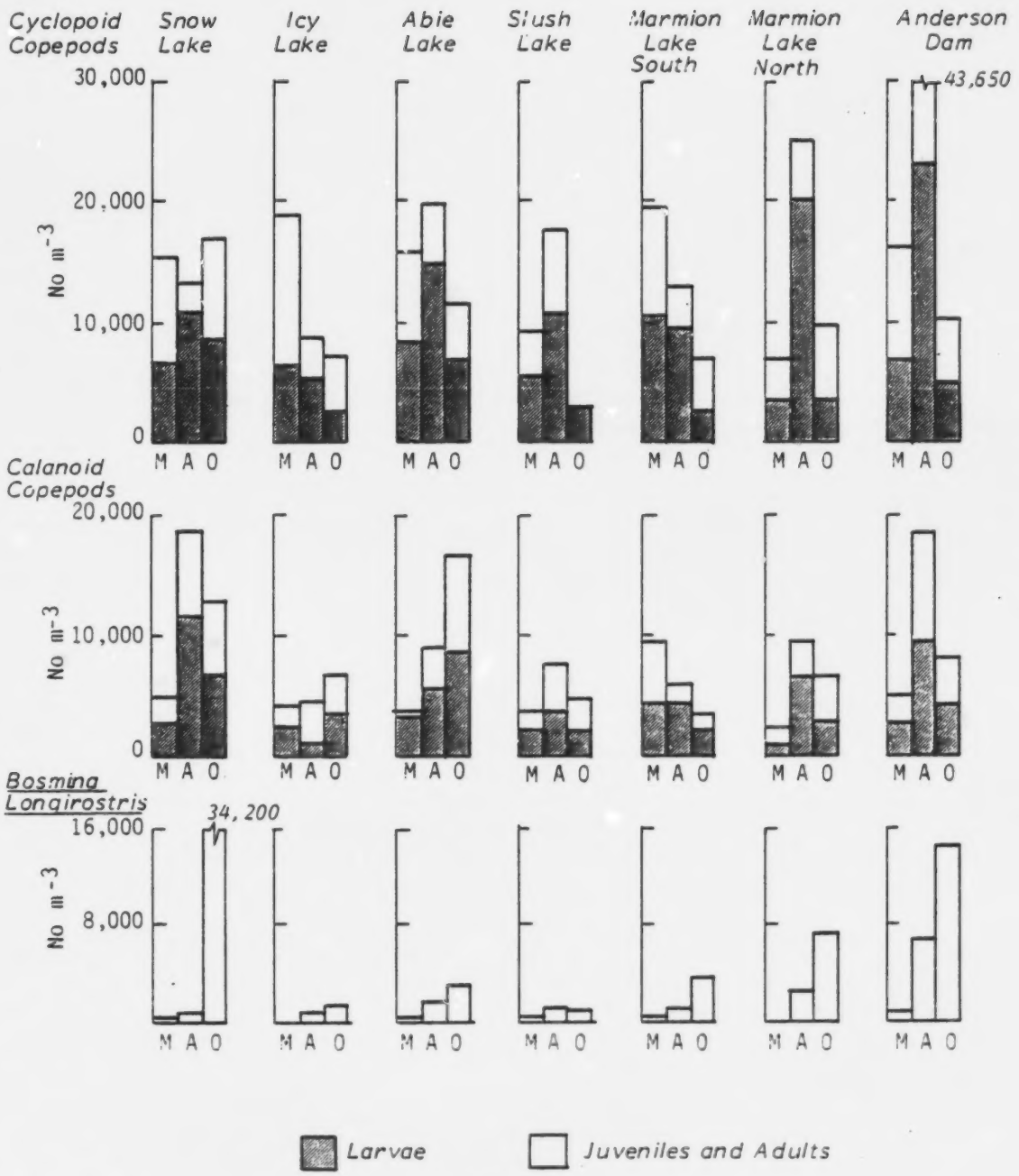


FIGURE 19

DENSITIES OF CYCLOPOID COPEPODS, CALANOID COPEPODS AND BOSMINA LONGIROSTRIS IN THE ATIKOKAN GS STUDY AREA IN MAY (M), AUGUST (A), AND OCTOBER (O) OF 1982

TABLE 20

NUMBER AND PERCENT COMPOSITION OF FISH CAUGHT IN BEACH SEINES
ATIKOKAN, MAY, AUGUST AND OCTOBER, 1982

Species	Snow Lake	Icy Lake	Able Lake	Marmion Lake						Total
				Lower Seine	South	Central	North	Anderson Dam	Moose	
Blacknose Shiner	108 (17.2)	8 (29.6)	2 (6.5)		85 (51.3)		157 (65.7)	1 (1.1)		561 (29.5)
Mimic Shiner	3 (0.5)			92 (29.0)	180 (32.4)		66 (27.6)	42 (47.7)		383 (20.1)
Pumpkinseed	354 (56.5)	6 (22.2)	4 (12.9)		2 (0.4)			1 (1.1)		367 (19.3)
Yellow Perch	2 (0.3)		9 (29.0)	203 (64.0)	6 (1.1)		6 (2.5)	9 (10.2)	9 (64.3)	244 (12.8)
Iowa Darter	109 (17.4)	6 (22.2)	9 (29.0)	12 (3.8)	24 (4.3)		1 (0.4)	5 (5.7)	3 (21.4)	169 (8.9)
White Sucker	40 (6.4)			4 (1.3)		1 (33.3)	2 (0.8)	5 (5.7)		52 (2.7)
Golden Shiner	5 (0.8)		1 (3.2)	4 (1.3)	31 (5.6)		5 (2.1)			46 (2.4)
Spottail Shiner		7 (25.9)	5 (16.1)		28 (5.0)					40 (2.1)
Log Perch						2 (66.7)		25 (28.4)	2 (14.3)	29 (1.5)
Slimy Sculpin	6 (1.0)			2 (0.6)			2 (0.8)			10 (0.5)
Northern Pike			1 (3.2)							1 (0.1)
Total	627	27	31	317	556	3	239	88	14	1902

The catch per beach seine during the three sampling occasions is presented in Table 21. Over the study area most fish were caught during August when young-of-the-year predominated in the catch. Blacknose and mimic shiners were generally the most abundant species on each sampling occasion.

All of the locations used for beach seining had little or no vegetation although the locations did vary in slope and substrate. A summary of major species relative to substrate and type of slope is presented in Table 22. Those beach seines conducted at locations with a sharp slope generally resulted in few fish, the majority of which were yellow perch. Those locations with slight or moderate slopes resulted in larger numbers of fish, with shiners very common. Although there appeared to be little variation among substrates sampled the data matrix was too limited to suggest trends. The low numbers of fish caught in beach seines at locations with sharp slopes may be related to the inefficiency of the gear in this situation. When water depth is greater than the height of the net, fish can escape capture over or under the seine.

Gill Nets

A total of 344 fish of seven species were captured in gill nets during 1982 (Table 23 and Appendix 7). White sucker was the most commonly caught species in May and October while cisco was the most common in August. A comparison of the effectiveness of gear types reveals that in 1981 only 207 fish were caught in the boxes and an additional 197 fish gilled in the leads of 1.2 and 1.8 m trap nets despite setting five times as many nets in 1981 than in 1982. The composition of the catch in trap nets was also different from that in gill nets with, in order of abundance, northern pike, walleye, white sucker and cisco being the most common species in the 1981 trap nets. Only four lake whitefish were sampled in 1981 trap nets while 59 were captured in the 1982 gill nets. Pumpkinseed was the lone species caught only in one gear (trap net).

The catch per two-hour gill net set of all species was highest at Marmion South and Anderson Dam (Table 24). On average, the catch per unit effort was higher in Marmion Lake (7.4) than in the upper chain of lakes (Snow, Icy and Abie Lakes, 4.9) and lowest in Slush (0.8) and Moose (1.2) Lakes. The main difference in the catches of Marmion Lake and the upper chain lakes were the contribution of coregonids (1.1 in the upper lakes and 3.5 in Marmion Lake).

TABLE 21

FISH CATCH PER BEACH SEINE - ATIKOKAN 1982

	Snow Lake	Icy Lake	Abie Lake	Marmion Lake					Moose Lake	Total
				Lower Seine	South	Central	North	Anderson Dam		
MAY										
Blacknose Shiner			0.3		6.7			0.3		0.8
Mimic Shiner				0.3	34.0			0.3		3.8
Yellow Perch	0.7				0.7				3.0	0.5
Iowa Darter	0.7		1.7		3.7					0.7
Golden Shiner	1.7				1.7				0.7	0.4
Spottail Shiner		1.0								0.1
Slimy Sculpin	1.7			0.3			0.7			0.3
Total	4.7	1.0	2.0	0.7	46.7	0.0	0.7	0.7	3.7	6.7
AUGUST										
Blacknose Shiner	35.3	2.7			55.3		52.0			16.1
Mimic Shiner	1.0				1.0		22.0	13.7		4.2
Pumpkinseed	117.3	2.0						0.3		13.3
Yellow Perch			2.7	67.0	0.7		2.0	0.7		8.1
Iowa Darter	34.7	1.3					0.3	1.7	0.3	4.3
White Sucker	13.3			1.3		0.3	0.7	1.7		1.9
Golden Shiner							1.7			0.2
Spottail Shiner		1.0	1.7		9.3	0.7				1.3
Logperch								7.3	0.7	1.0
Total	102.7	7.0	4.3	68.3	66.3	1.0	78.7	25.3	1.0	50.4
OCTOBER										
Blacknose Shiner	0.7		0.3		33.0		0.3			3.8
Mimic Shiner				30.3	25.0					6.1
Pumpkinseed	0.7		1.3		0.7					0.3
Yellow Perch			0.3	0.7	0.7			2.3		0.4
Iowa Darter	1.0	0.7	1.3	4.0	4.3					1.3
Golden Shiner			0.3	1.3	8.7					1.1
Spottail Shiner		0.3								*0.0
Logperch								1.0		0.1
Slimy Sculpin	0.3			0.3						0.1
Northern Pike				0.3						0.0
Total	2.7	1.0	4.0	36.7	72.3	0.0	0.3	3.3	0.0	13.4

TABLE 22

COMPARISON OF COMMON SPECIES IN BEACH SEINE CATCHES WITH SUBSTRATE AND SLOPE

Substrate	Slope		
	Slight	Moderate*	Sharp
Sand-Gravel	MS - Blacknose Shiner - Mimic Shiner - Spottail Shiner Icy - Few SL - White Sucker - Pumpkinseed - Iowa Darter - Blacknose Shiner	AD - Mimic Shiner - Logperch	LS** - Yellow Perch - Mimic Shiner AB - Few
Mud		MN - Blacknose Shiner - Mimic Shiner	AB - Few ML - Few - Yellow Perch
Rock			MC - Few LS - Yellow Perch - Mimic Shiner

MS - Marmion South
SL - Snow Lake
AD - Anderson Dam
MN - Marmion North
LS - Lower Seine
AB - Abie Lake
ML - Moose Lake
MC - Marmion Central

* a slight slope near shore dropping off rapidly offshore
** Lower Seine and Abie Lake have a combination of two substrates

TABLE 23

SUMMARY OF GILL NET CATCHES - ATIKOKAN 1982

	May	August	October	Total
White Sucker	24 (21.6)[1]	15 (20.3)	49 (30.8)	88 (25.6)
Cisco	16 (14.4)	30 (40.5)	24 (15.1)	70 (20.3)
Northern Pike	26 (23.4)	13 (17.6)	23 (14.5)	62 (18.0)
Lake Whitefish	17 (15.3)	8 (10.8)	34 (21.4)	59 (17.2)
Walleye	14 (12.6)	4 (5.4)	24 (15.1)	42 (12.2)
Yellow Perch	14 (12.6)	4 (5.4)	4 (2.5)	22 (6.4)
Burbot	0 (0.0)	0 (0.0)	1 (0.6)	1 (0.3)
Totals	111	74	159	344

1. number and percent

TABLE 24

CATCH PER UNIT EFFORT (2 h SET) OF FISH IN GILL NETS

	Snow Lake		Icy Lake		Able Lake		Slush Lake		Marston Lake										Moose Lake		Mean
									Lower Seine		South		Central		North		Anderson Dam				
	IS	OS	IS	OS	IS	OS	IS	OS	IS	OS	IS	OS	IS	OS	IS	OS	IS	OS	IS	OS	
White Sucker	1.3	3.3	1.2	1.0	4.7	0.7	0.2	0	0	0	0	0	1.3	3.7	3.1	0.3	3.7	2.7	0.7	0	1.4
Cisco	0	1.7	0.9	1.0	0.3	0.3	0	0	0.7	0.7	1.3	8.3	3.0	0	0.3	3.0	1.0	0.3	0	0	1.4[1]
Northern Pike	0	0.9	1.9	2.1	1.7	0.7	1.2	0	0	0	1.0	1.0	0	0.3	1.0	0.2	4.3	0.7	0.7	0	0.9
Lake Whitefish	0	0	0	0	1.0	1.3	0	0	0.7	1.7	3.0	5.3	1.7	2.0	0	0	1.0	1.0	1.0	0	1.4[2]
Walleye	0	0	1.1	0.3	0	0	0	0	1.0	0.3	1.0	1.3	0.7	0.7	1.0	0.2	2.0	2.0	0	0	0.7[3]
Yellow Perch	0	0	1.3	0	0	0	0	0	0.3	0	3.0	0	0	0.3	0	0	1.0	1.3	0	0	0.4
Burbot	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Total	1.3	5.9	6.4	4.4	6.7	3.0	1.5	0	2.7	2.7	9.3	15.9	6.7	7.0	5.4	3.5	13.0	8.0	2.4	0	6.2

IS - Inshore
OS - Offshore

1-3 - Excluding those lakes where cisco, lake whitefish or walleye have not been found in 1981 or 1982.

Although the offshore nets in Slush and Moose Lakes caught no fish, there were no consistent trends in the catches of nets set inshore and of those set offshore.

A total of 15 species of fish were identified from beach seines and gill nets in the Atikokan lakes during 1982, all of which were included in the 23 species identified during the more intensive 1981 study (Table 25). Only the species list for Snow Lake was increased in 1982 with the collection of cisco from that basin.

Age and Growth

The age distribution of walleye, northern pike, lake whitefish and cisco are presented in Figure 20. Walleye ranged in age from two to 15 years with the 1977 year-class (age 5) the most common. Northern pike ranged from two to nine years with the 1979 (age 3) and 1976 (age 6) year-classes most abundant. Both coregonids ranged in age from three to 11 years. With the exception of the 1976 year-class pike, the most common year-classes were not the same as the most common in the 1981 sampling.

A comparison of fork lengths at age of fish caught in 1981 with those caught in 1982 (Table 26) reveals that, with the exception of age 7+ and 9+ walleye, mean fork lengths at age in 1982 were within 10% of those in 1981 (where sample size was ≥ 5 fish). Cisco were not sampled in 1981.

Lengths and weights of fish captured in 1982 are compared to regressions calculated for 1981 fish in Figures 21 and 22. Length-weights of fish captured in 1982 were very similar to the regressions calculated from fish measured in 1981.

Mark-Recapture

A total of 81 walleye and 62 pike were tagged during 1982. Combined with those tagged during 1981, 151 walleye and 248 pike have been tagged in the study lakes. A small number of cisco and lake whitefish were also tagged during 1982; however, gill netting and handling of the coregonids resulted, in many cases, in substantial scale loss ard tagging was discontinued.

Only four returns were recorded during 1982 (three pike and one walleye), three from fishermen and one from our netting program. Two of these fish were tagged in 1981 and two in 1982 (Table 27). In each case the fish was caught in the same basin in which it was tagged. The pike which was recaptured in our nets was tagged one year earlier at the same location, was five years old when tagged and increased in size by 27 mm and 180 g.

TABLE 25

FISH SPECIES LISTS - ATIKOKAN 1981 AND 1982

	Moose Lake	Snow Lake	Icy Lake	Slush Lake	Fotheringham Lake	Abie Lake	Marmion Lake					Total
							Lower Seine	South	Central	North	Anderson Dam	
Cisco		0	X			X	X	X	X	X	X	X
Lake Whitefish	X	X				X	X	X	X		X	X
Northern Pike	X	X	X	X	X	X	X	X	X	X	X	X
Redbelly Dace						X						
Finescale Dace						X					X	X
Lake Chub			X			X		X		X		X
Golden Shiner	X	X				X	X	X	X	X		X
Emerald Shiner						X		X				X
Blacknose Shiner	X	X	X	X	X	X	X	X	X	X	X	X
Spottail Shiner		X	X			X	X	X	X	X	X	X
Mimic Shiner	X	X	X			X	X	X	X	X	X	X
Bluntnose Minnow										X	X	X
Fathead Minnow											X	X
White Sucker	X	X	X	X	X	X	X	X	X	X	X	X
Burbot		X		X	X		X	X	X	X		X
Nine-spine Stickleback							X	X		X	X	X
Trout-Perch											X	X
Pumpkinseed		X	X			X	X		X	X	X	X
Yellow Perch	X	X	X	X	X	X	X	X	X	X	X	X
Walleye	X		X			X	X	X	X	X	X	X
Iowa Darter	X	X	X		X	X	X	X	X	X	X	X
Logperch		X	X			X	X	X	X	X	X	X
Slimy Sculpin		X	X				X		X	X		X
Total Species	9	13	13	5	6	17	16	16	15	17	17	22

0 species identified in 1982 but not in 1981

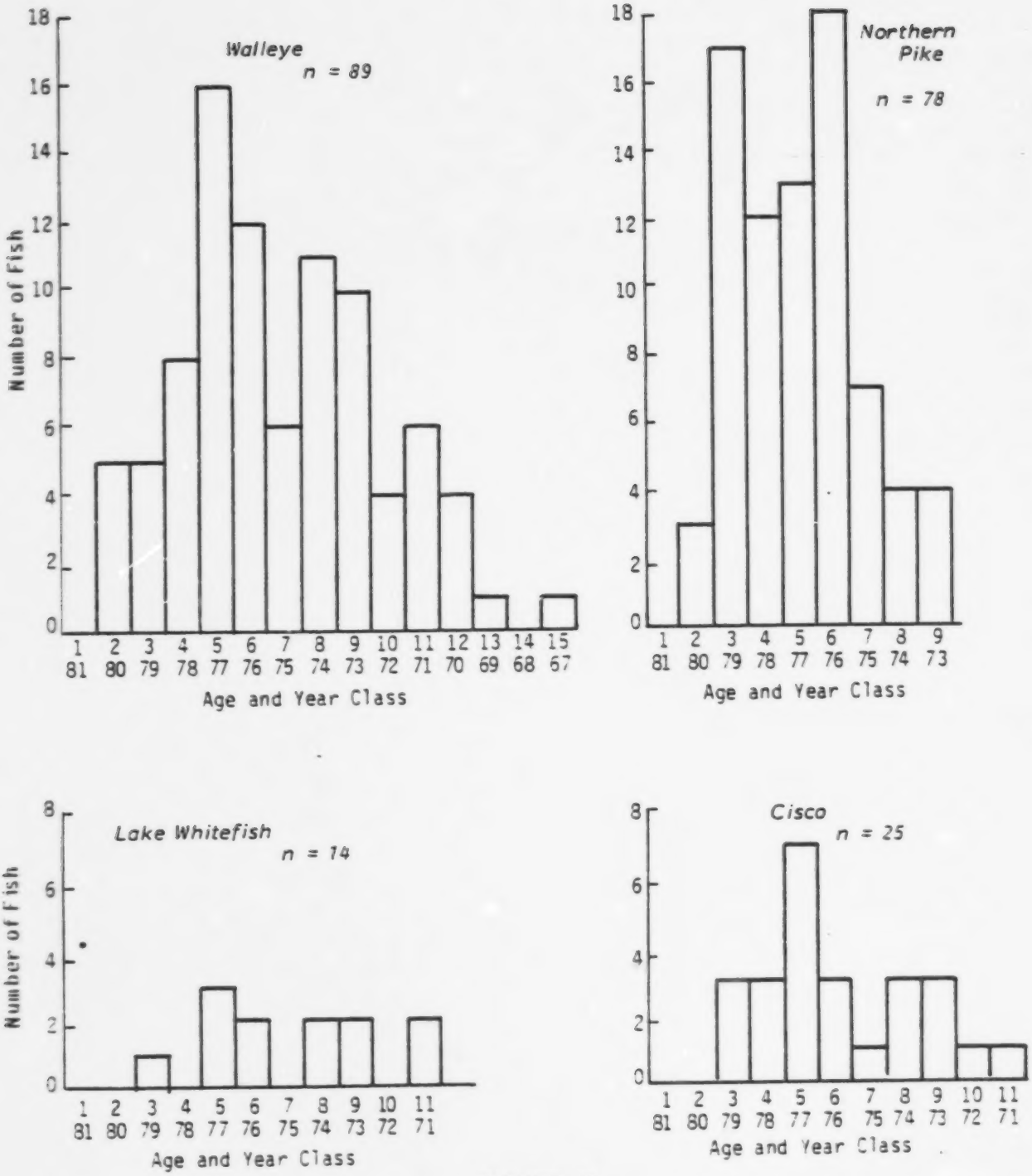


FIGURE 20

AGE DISTRIBUTION OF WALLEYE, PIKE, WHITEFISH AND CISCO, ATIKOKAN 1982

TABLE 26

MEAN FORK-LENGTH (mm) OF WALLEYE, NORTHERN PIKE, LAKE WHITEFISH AND CISCO
ATIKOKAN 1981, 1982

	Age	1+	2+	3+	4+	5+	6+	7+	8+	9+	10+	11+	12+	13+	14+	15+
Walleye	1981	188	258	307	351	403	428	514	524	529	-	636	568	713	596	-
	n	1	13	26	10	8	10	5	6	9		4	1	1	1	-
	1982	-	274	329	374	295	411	422	473	463	545	579	589	692	-	666
	h		5	5	8	16	12	6	11	9	4	6	4	1		1
Northern	1981	-	250	420	445	496	567	625	663	673	694	456	882	900		
Pike	n		1	14	40	43	16	17	11	4	1	1	1	1		
	1981	-	325	445	481	522	585	645	660	750	-	-	-	-		
	n		3	17	12	13	18	7	4	4						
Lake	1981	-	245	282	340	323	352	427	399	427	441	456	522	494		
Whitefish	n		1	3	1	7	6	6	6	16	8	8	1	1		
	1982	-	-	225	-	319	354	-	370	423	-	468	-	-		
	n			1		3	2		2	2		2				
Cisco	1982	-	-	201	237	259	305	341	362	349	383	387				
	n			3	3	7	3	1	3	3	1	1				

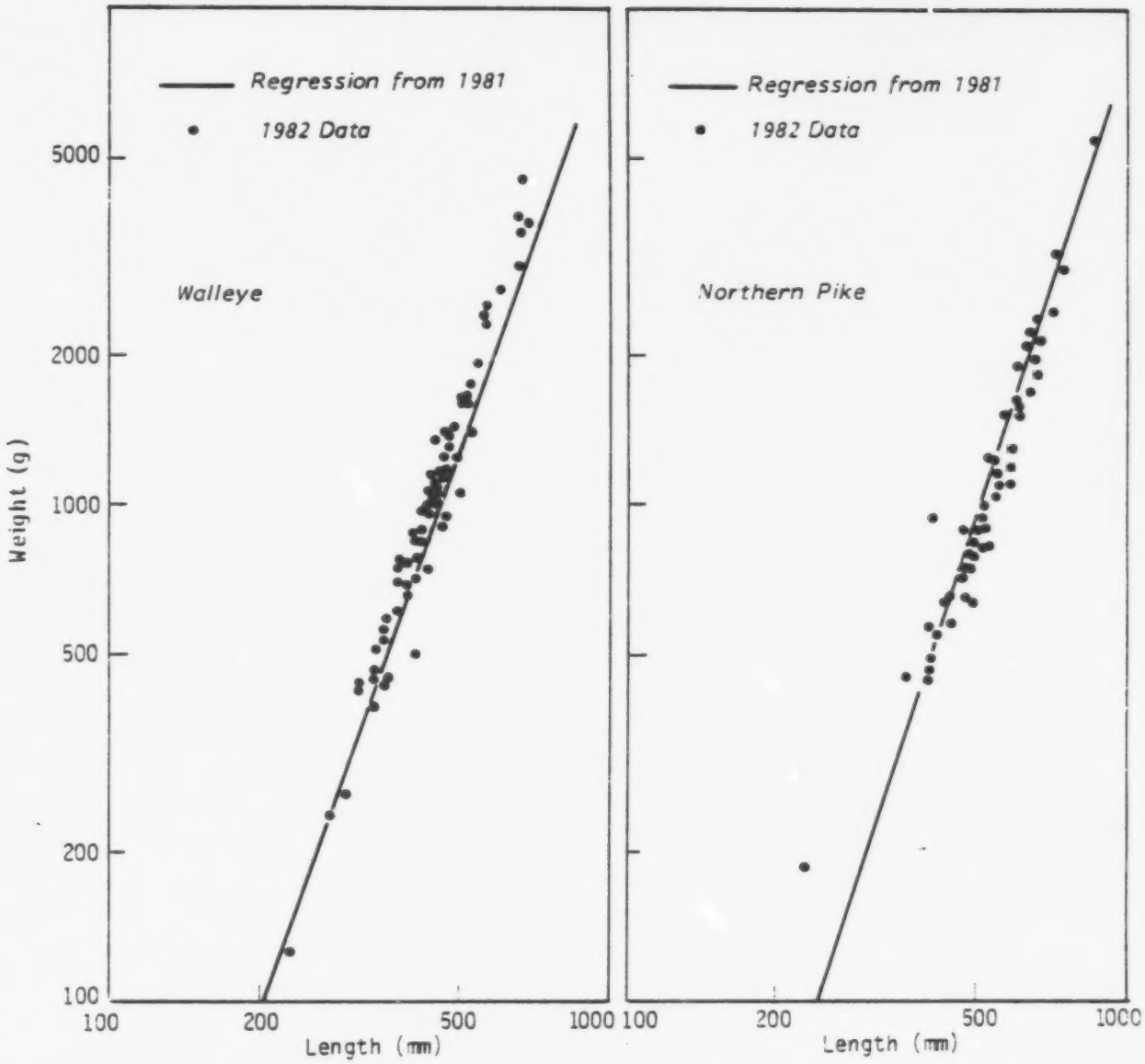


FIGURE 21

LENGTH-WEIGHT DATA, WALLEYE AND PIKE,
ATIKOKAN, 1981 AND 1982

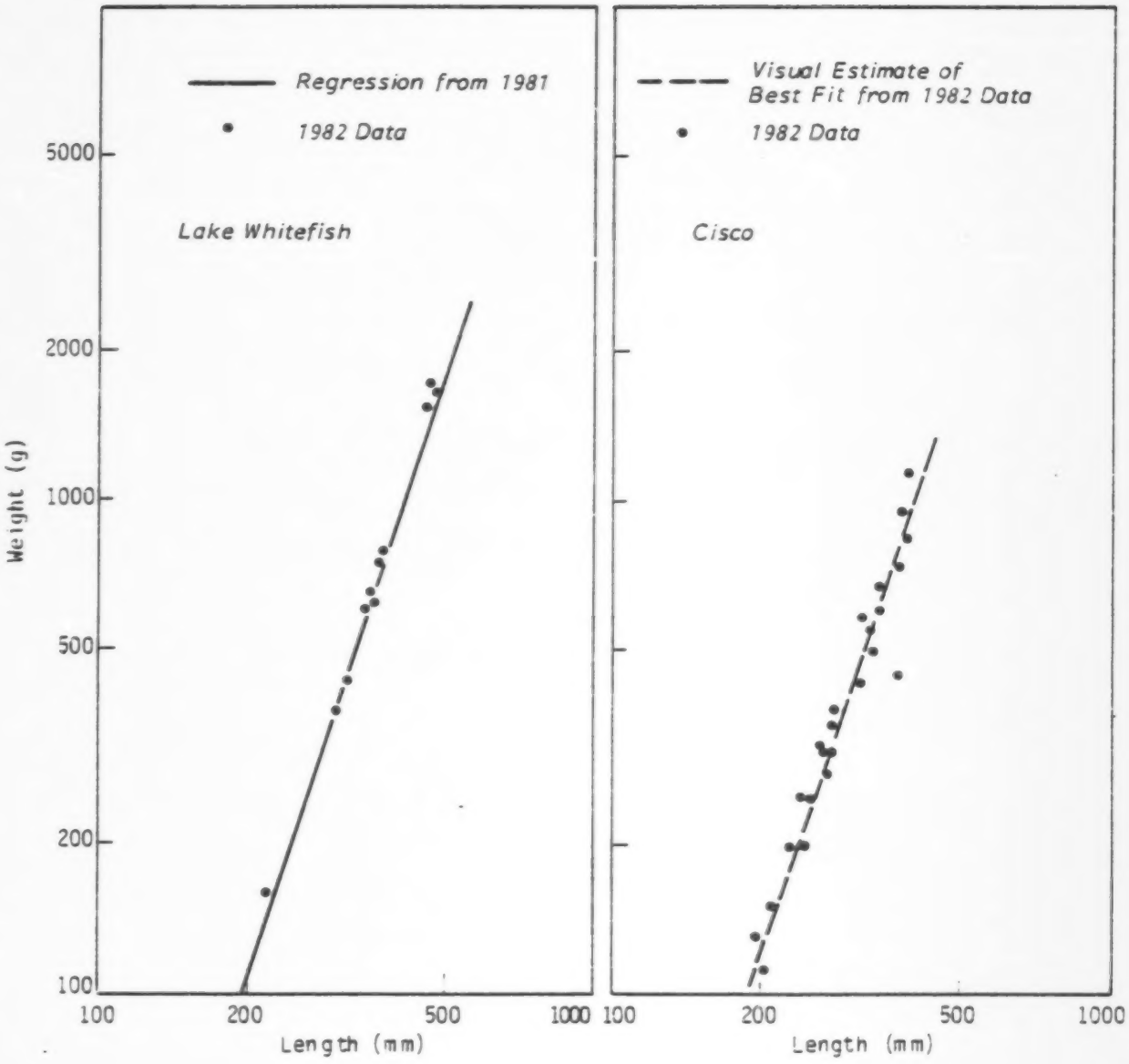


FIGURE 22

LENGTH-WEIGHT DATA, LAKE WHITEFISH
AND CISCO ATIKOKAN 1981 AND 1982

Spawning

Walleye were observed and probably spawned at the West Dam and the outlet of Ski Lake. Very few walleye were observed at the latter location as water levels were very low.

The only location which was identified as a walleye spawning site during 1981, but was probably not utilized during 1982, was the outlet of Icy Lake into Abie Lake. On May 6 the rocky substrate at the outlet of Icy Lake was heavily silted, probably due to the earlier widening of the outlet and, as such, would not be ideal spawning habitat. Walleye which normally spawned at the outlet of Icy Lake may have moved up into Icy Lake and spawned at the outlet of Ski Lake. The silt at the outlet of Icy Lake had been washed away by May 14.

At the West Dam, 52 ripe walleye were collected by beach seine and dip net on May 5 and 7. Of these only five were female. The water temperatures on these dates were 6 to 7°C. Spent walleye were collected at Anderson Dam on May 12 and from Lower Seine on May 14. The temperature at these locations was 9°C.

A ripe northern pike was collected from Icy Lake on May 11 at a temperature of 9°C. Spent pike were collected as early as May 9 at a temperature of 9°C.

These results would suggest that both walleye and pike spawned during the first two weeks of May before water temperatures reached about 10°C.

4.0 CONCLUSIONS

Generally, most physical-chemical and biological parameters measured during year II of the preoperational study at Atikokan were similar to those measured during year I. Differences, however, occurred in the mean pH values for the lakes of the system which may have been an artifact of sampling schedule, and in the composition of the fish catch due mainly to a change from trap nets in 1981 to gill nets in 1982. The results of the year II study are summarized below.

1. The lakes in the system stratified during the summer and this stratification was associated with some hypolimnetic anoxia. Oxygen depletion was also apparent near the bottom during February.

2. During 1982 dredging and construction activities resulted in little or no flow between the lakes of the cooling circuit.

TABLE 27

RECAPTURES OF MARKED NORTHERN PIKE AND WALLEYE
ATIKOKAN 1981-1982

Basin		Number Tagged		Number Recaptured[1]		Per Cent Recaptured		Site of Recapture	
		Pike	Walleye	Pike	Walleye	Pike	Walleye	Pike	Walleye
Snow Lake	1981	2	0	0	0	0.0	-		
	1982	17	0	0	0	0.0	-		
Icy Lake	1981	17	5	0	0	0.0	0.0		
	1982	12	3	0	0	0.0	0.0		
Able Lake	1981	26	22	2	3	7.7	13.6	AB	AB-1,HnL-2
	1982	4	0	0	0	0.0	0.0		
Slush Lake	1981	5	0	0	0	0.0	-		
	1982	1	0	0	0	0.0	-		
Marmion Lake South	1981	3	2	0	0	0.0	0.0		
	1982	3	8	0	0	0.0	0.0		
Central	1981	6	7	0	0	0.0	0.0		
	1982	0	3	0	0	-	0.0		
North	1981	16	5	0	0	0.0	0.0		
	1982	2	55	0	1	0.0			
Anderson Dam	1981	42	25	4	0	9.5	0.0	AD	
	1982	11	8	1	0	9.1	0.0	HnL	
Lower Seine	1981	10	3	0	0	0.0	0.0		
	1982	0	4	0	0	-	0.0		
House Lake	1981	47	1	2	0	4.3	0.0	HL	
	1982	7	0	0	0	0.0	0.0		
Totals	1981	186	70	8	3	4.3	4.3		
	1982	62	81	1	1	1.6	1.2		
TOTAL		248	151	9	4	3.6	2.6		

[1] recaptures include those captured during netting program and those returned by fishermen.

AB - Able Lake
HnL - Marmion Lake
HL - House Lake
AD - Anderson Dam

3. Based on surface and bottom water chemistry samples collected in May, August and October, the lakes included in this study were found to have low alkalinity with moderate levels of nutrients and ions. Copper, manganese and iron were the only metals present in detectable concentrations. The pH of the lakes were generally close to neutral with lower pH found in May than in August or October. Most parameters monitored were found in higher levels in Icy Lake and to some extent in Abie Lake, while lower levels of most parameters were found in Slush Lake.

   Alkalinity measurements in embayments of the lakes indicated that the alkalinity in the bays were similar to those measured at the maximum depth of the corresponding lakes.

   Concentrations of iron, arsenic and aluminum were substantially higher in macrophytes than in fish, while copper and zinc were at similar concentration in macrophytes and fish. The mean mercury concentration in northern pike (0.7 mg/kg wet weight) from Slush Lake was calculated to be above the MOE (1978) guideline.

4. Forty-four species of macrophytes were identified in the seven areas selected for detailed documentation of aquatic vegetation in 1982. Most of these were submergent species and most were observed in 1981. The vegetation was generally distributed in a zonal pattern which was associated with changes in water depth and which is considered typical of temperate lakes. Patchily distributed vegetation occurred in three locations where either disturbance from drawdown or construction activity or substrate variability were considered important factors determining vegetation patterns. The maximum depth at which vegetation was observed in any of the study areas was 3.5 m. The maximum depth vegetated at all locations was generally less than the Secchi depth measured in 1981.

5. Phytoplankton samples collected from the study lakes in May, August and October indicated that the flagellates, followed by the diatoms, were the main algae present in the study area. In terms of phytoplankton species composition, Snow Lake differed most from the other lakes due to the high proportion of blue-greens found in this lake. Snow Lake was also the lake with the highest mean algal biomass. Lowest algal biomass was found at Marmion North. Total phytoplankton biomass was highest in May at all locations except Anderson Dam where it was highest in October.

6. May, August and October zooplankton samples collected from the study lakes identified *Keratella cochlearis*, *Polyarthra* and *Kellicottia longispina* as the main rotifers of the study area. The rotifer species composition in Icy Lake was most different from the other lakes in its high abundance of *Brachionus angularis*.

   The mean total number of rotifers for the three sampling occasions was higher in Snow, Icy and Abie Lakes than at the Marmion Lake locations and at Slush Lake where lowest numbers were estimated. Rotifer abundances were higher in October than in May or August.

   The cyclopoid copepods were the most abundant crustacean zooplankton in all the study lakes with the exception of Snow Lake where the cladocerans were more prominent.

   Higher numbers of crustacean zooplankton were found at Anderson Dam and Snow Lake than at the remaining locations while lower numbers were found at Slush and Icy Lakes. Highest total crustracean zooplankton abundances were estimated for August at all locations.

7. Blacknose shiner and mimic shiner were the most commonly caught fish species in beach seines while white sucker and cisco were the most commonly caught species in gill nets. Marmion South had the highest mean catch per unit effort for both beach seines and gill nets.

   Walleye probably spawned at the West Dam and at the outflow of Ski Lake into Icy Lake. No walleye were observed at the outflows of Icy or Abie Lakes where spawning had been previously observed.

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GTH:lg

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APPENDIX 2

SURFACE TEMPERATURE GRID, SNOW LAKE
AUGUST 19, 1982

APPENDIX 2 (CONT.)

SURFACE TEMPERATURE GRID (°C)
ICY LAKE, AUGUST 18, 1982

N
20.6
21.2
21.3
20.7
20.7
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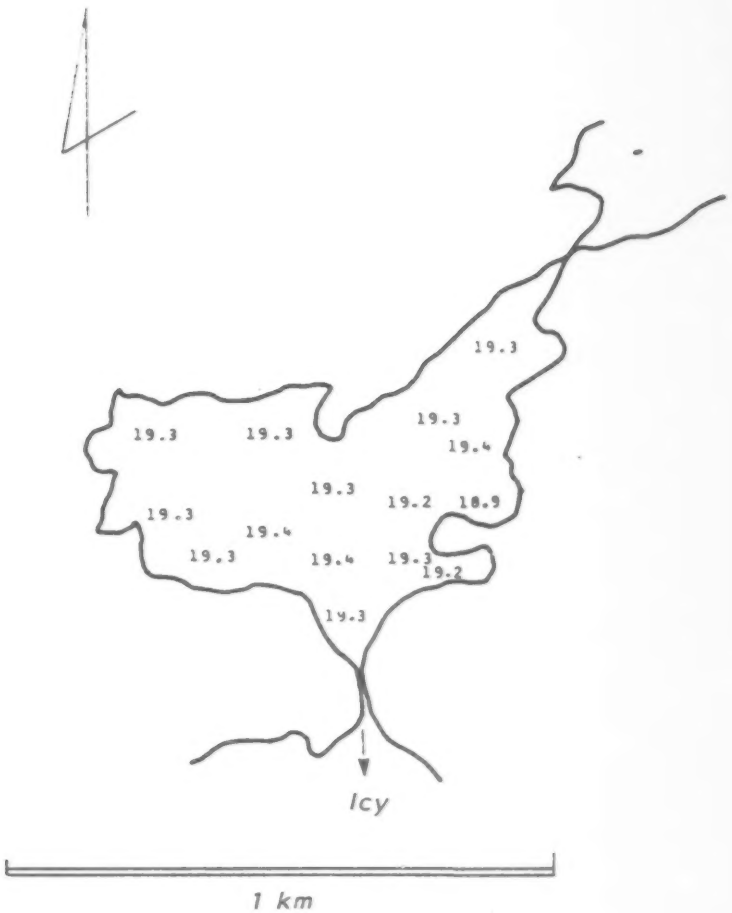


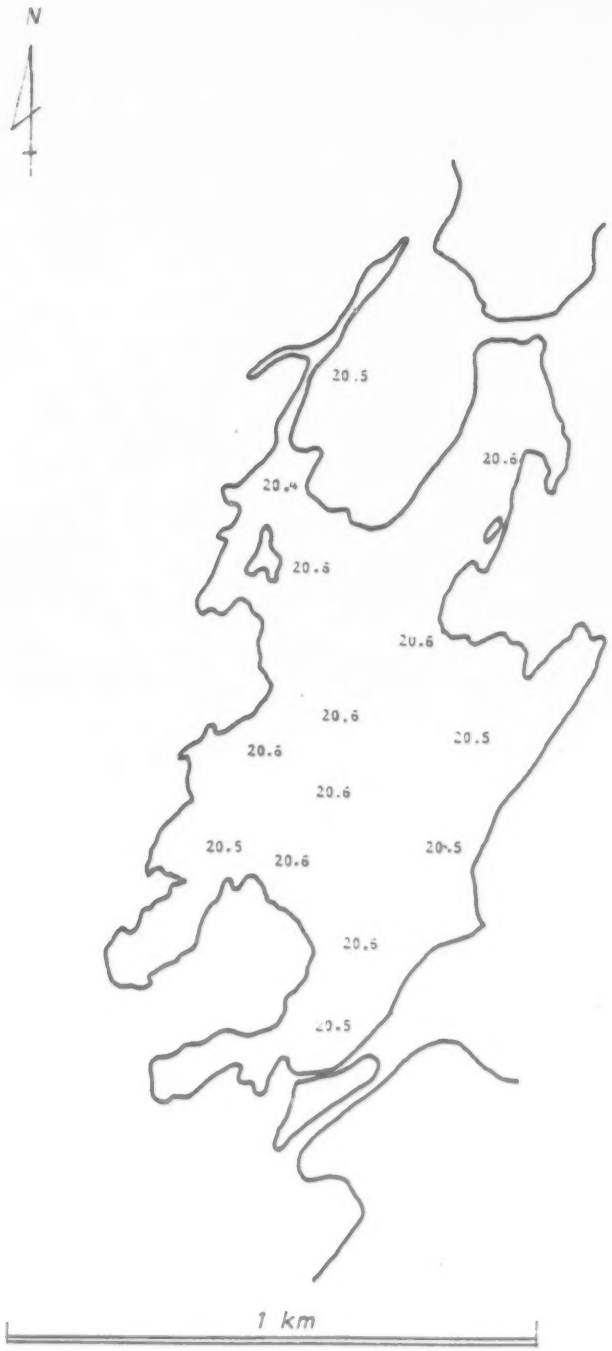
APPENDIX 2 (CONT.)

SURFACE TEMPERATURE GRID (°C) SLUSH LAKE
AUGUST 24, 1982

APPENDIX 2 (CONT.)

SURFACE TEMPERATURE GRID °C MARMION LAKE INCLUDING LOWER SEINE AUGUST 24, 1982

84-54



APPENDIX 2 (CONT.)

SURFACE TEMPERATURE GRID (°C)
MOOSE LAKE, AUGUST 20, 1982

APPENDIX 3

WATER CHEMISTRY- SNOW LAKE - ATIKOKAN 1982

Parameter	May		August		October	
	Surface	Bottom	Surface	Bottom	Surface	Bottom
Turbidity (NTU)	1.3	1.5	0.8	1.5	0.9	1.0
Specific Conductance (mS/m)	8.3	9.0	8.8	8.3	10.1	10.5
Non-filtrable 105°C (mg/L)	1.6	2.4	4.0	4.0	<2.0	<2.0
Residues 550°C (mg/L)	<0.5	1.0	2.0	2.0	<2.0	<2.0
Filtrable 105°C (mg/L)	50	49	71	67	74	89
Residues 550°C (mg/L)	30	32	50	47	55	68
Colour	none	none	none	none	none	none
pH	6.7	6.5	7.3	6.8	7.4	7.4
Alkalinity (HCO_3 as $CaCO_3$) (mg/L)	(30)[1]		(39)[1]		(39)[1]	
Hardness ($CaCO_3$) (mg/L)	NA	NA	44	42	46	46
Calcium (mg/L)	NA	NA	15	14	15	15
Magnesium (mg/L)	NA	NA	1.9	1.8	2.2	2.2
Sodium (mg/L)	NA	NA	1.8	1.6	1.9	1.9
Sulphate (SO_4) (mg/L)	7.6	7.9	5.5	3.6	5.0	5.1
Suspended Iron (mg/L)	33	47	83	155	205	114
Dissolved Iron (mg/L)	NA	NA	0.08	0.19	0.10	0.18
Nickel (mg/L)	NA	NA	<0.005	<0.005	<0.005	<0.005
Aluminum (mg/L)	NA	NA	<0.5	<0.5	<0.5	<0.5
Zinc (mg/L)	NA	NA	<0.02	<0.02	<0.02	<0.02
Copper (mg/L)	NA	NA	0.008	0.002	0.001	0.001
Manganese (mg/L)	NA	NA	0.004	0.500	0.004	0.004
Mercury (filtered) (µg/L)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Total Organic Carbon (mg/L)	9	8	11	11	11	11
Total Inorganic Carbon (mg/L)	5	6	9	11	7	7
Chloride (mg/L)	1.8	1.8	2.5	13	1.7	1.8
Potassium (mg/L)	NA	NA	0.60	0.57	0.72	0.72
Total Phosphorus (mg/L)	NA	NA	0.015	0.041	0.007	0.014
Soluble Phosphorus (mg/L)	NA	NA	0.009	0.013	<0.003	<0.003
Total Phosphate (as P) (mg/L)	0.016	0.026	NA	NA	NA	NA
Soluble Phosphate (as P) (mg/L)	0.019	0.016	NA	NA	NA	NA
Total Kjeldahl Nitrogen (mg/L)	<0.10	0.10	0.13	0.20	0.18	0.16
Nitrate (NO_3) (mg/L)	<0.10	<0.10	0.58	2.00	0.06	0.06
Total Silica (mg/L)	3.3	4.3	1.2	7.2	1.9	2.0
Soluble Silica (mg/L)	1.5	2.1	0.8	1.7	1.2	1.3
Ammonia (NH_3) (mg/L)	<0.01	0.02	0.02	0.01	0.19	0.04
Arsenic (mg/L)	NA	NA	0.001	0.002	<0.002	<0.002
Selenium (mg/L)	NA	NA	<0.002	<0.002	<0.001	<0.001

[1] Surface to Bottom Sample

NA - Not Analyzed

APPENDIX 3 (cont'd)

WATER CHEMISTRY- ICY LAKE - ATIKOKAN 1982

Parameter	May		August		October	
	Surface	Bottom	Surface	Bottom	Surface	Bottom
Turbidity (NTU)	1.7	2.0	1.1	2.3	1.5	1.3
Specific Conductance (mS/m)	15	15	13	14	16	16
Non-filtrable Residues 105°C (mg/L)	2.2	2.0	5.5	5.5	2.0	<2.0
Non-filtrable Residues 550°C (mg/L)	<0.5	<0.5	1.0	4.5	<2.0	<2.0
Filtrable Residues 105°C (mg/L)	92	82	104	105	100	100
Filtrable Residues 550°C (mg/L)	63	65	85	88	71	71
Colour	None	None	None	None	None	None
pH	6.8	6.7	7.5	7.0	7.5	7.5
Alkalinity (HCO_3 as $CaCO_3$) (mg/L)	(62)[1]		X		(62)[1]	
Hardness ($CaCO_3$) (mg/L)	NA	NA	67	73	65	65
Calcium (mg/L)	NA	NA	21	23	20	20
Magnesium (mg/L)	NA	NA	3.5	3.7	3.8	3.8
Sodium (mg/L)	NA	NA	3.8	3.8	4.0	4.1
Sulphate (SO_4) (mg/L)	4.6	4.4	4.4	4.0	4.0	4.0
Suspended Iron (mg/L)	48	76	68	220	117	121
Dissolved Iron (mg/L)	NA	NA	0.08	0.29	0.20	0.19
Nickel (mg/L)	NA	NA	<0.005	<0.005	<0.005	<0.005
Aluminum (mg/L)	NA	NA	<0.5	<0.5	<0.5	<0.5
Copper (mg/L)	NA	NA	0.009	0.020	<0.001	0.001
Zinc (mg/L)	NA	NA	<0.02	<0.02	<0.02	<0.02
Manganese (mg/L)	NA	NA	0.12	1.20	0.24	0.23
Mercury (filtered) (µg/L)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Total Organic Carbon (mg/L)	8	9	14	14	11	11
Total Inorganic Carbon (mg/L)	13	13	16	19	13	13
Chloride (mg/L)	4.8	4.9	5.2	5.2	5.4	5.4
Potassium (mg/L)	NA	NA	0.91	1.03	1.02	1.02
Total Phosphorus (mg/L)	NA	NA	0.020	0.060	<0.003	0.004
Soluble Phosphorus (mg/L)	NA	NA	0.013	0.014	<0.003	<0.003
Total Phosphate (as P) (mg/L)	<0.010	0.014	NA	NA	NA	NA
Soluble Phosphate (as P) (mg/L)	<0.010	<0.010	NA	NA	NA	NA
Total Kjeldahl Nitrogen (mg/L)	0.15	0.24	0.15	0.18	0.19	0.19
Nitrate (NO_3) (mg/L)	<0.10	0.30	0.04	0.01	0.09	0.07
Total Silica (mg/L)	4.9	5.3	3.0	6.6	4.2	4.3
Soluble Silica (mg/L)	2.3	3.0	3.0	4.9	4.1	4.3
Ammonia (NH_3) (mg/L)	<0.01	0.05	0.01	0.02	0.08	0.08
Arsenic (mg/L)	NA	NA	0.001	0.004	<0.002	<0.002
Selenium (mg/L)	NA	NA	<0.002	<0.002	<0.001	<0.001

X Bottle cracked
[1] Surface to Bottom Sample
NA - Not Analyzed

APPENDIX 3 (cont'd)

WATER CHEMISTRY- ABIE LAKE - ATIKOKAN 1982

Parameter	August		October	
	Surface	Bottom	Surface	Bottom
Turbidity (NTU)	0.45	0.71	1.00	1.10
Specific Conductance (mS/m)	10.8	11.5	12.0	12.4
Non-filtrable Residues 105°C (mg/L)	1.5	<1.0	<2.0	<2.0
Non-filtrable Residues 550°C (mg/L)	1.0	<1.0	<2.0	<2.0
Filtrable Residues 105°C (mg/L)	94	97	110	89
Filtrable Residues 550°C (mg/L)	69	64	82	65
Colour	None	None	None	None
pH	7.3	7.1	7.4	7.5
Alkalinity (HCO_3 as $CaCO_3$) (mg/L)	(51)[1]		(51)[1]	
Hardness ($CaCO_3$) (mg/L)	51	55	56	56
Calcium (mg/L)	16	17	17	17
Magnesium (mg/L)	2.8	3.0	3.3	3.4
Sodium (mg/L)	3.1	3.3	3.2	3.3
Sulphate (SO_4) (mg/L)	4.8	4.6	4.0	4.1
Suspended Iron (mg/L)	34	54	76	69
Dissolved Iron (mg/L)	<0.05	0.10	0.07	0.08
Nickel (mg/L)	<0.005	<0.005	<0.005	<0.005
Aluminum (mg/L)	<0.5	<0.5	<0.5	<0.5
Copper (mg/L)	0.003	0.006	0.002	0.001
Zinc (mg/L)	<0.02	<0.02	<0.02	<0.02
Manganese (mg/L)	0.03	0.16	0.04	0.05
Mercury (filtered) (µg/L)	<0.2	<0.2	<0.2	<0.2
Total Organic Carbon (mg/L)	12	11	11	11
Total Inorganic Carbon (mg/L)	12	14	10	11
Chloride (mg/L)	3.8	3.9	3.9	4.1
Potassium (mg/L)	0.80	0.84	0.92	0.91
Total Phosphorus (mg/L)	0.026	0.036	<0.003	0.006
Soluble Phosphorus (mg/L)	0.007	0.013	<0.003	<0.003
Total Kjeldahl Nitrogen (mg/L)	0.14	0.15	0.17	0.31
Nitrate (NO_3) (mg/L)	2.90	0.05	0.04	0.06
Total Silica (mg/L)	7.8	3.8	3.4	4.0
Soluble Silica (mg/L)	2.1	3.3	2.4	3.4
Ammonia (NH_3) (mg/L)	0.01	0.02	0.05	0.05
Arsenic (mg/L)	<0.001	<0.001	<0.002	<0.002
Selenium (mg/L)	<0.002	<0.002	<0.001	0.003

[1] Surface to Bottom Sample

APPENDIX 3 (cont'd)

WATER CHEMISTRY- SLUSH LAKE - ATIKOKAN 1982

Parameter	May		August		October	
	Surface	Bottom	Surface	Bottom	Surface	Bottom
Turbidity (NTU)	1.3	2.0	0.4	0.4	0.8	1.6
Specific Conductance (mS/m)	5.2	5.5	4.6	4.8	5.5	6.0
Non-filtrable 105°C (mg/L)	2.8	2.4	2.0	2.5	<2.0	3.0
Residues 550°C (mg/L)	0.5	<0.5	<1.0	1.5	<2.0	2.0
Filtrable 105°C (mg/L)	31	28	44	47	44	70
Residues 550°C (mg/L)	23	18	33	25	27	61
Colour	None	None	None	None	None	None
pH	6.7	6.1	7.2	6.5	7.2	6.5
Alkalinity (HCO_3 as $CaCO_3$) (mg/L)	(20)[1]		(22)[1]		(22)[1]	
Hardness ($CaCO_3$) (mg/L)	NA	NA	23	24	25	27
Calcium (mg/L)	NA	NA	7.8	8.2	8.3	9.0
Magnesium (mg/L)	NA	NA	0.8	0.9	1.1	1.2
Sodium (mg/L)	NA	NA	0.62	0.66	0.62	0.66
Sulphate (SO_4) (mg/L)	2.0	1.9	2.3	2.0	2.0	1.8
Suspended Iron (mg/L)	48	78	42	90	51	207
Dissolved Iron (mg/L)	NA	NA	<0.005	0.10	0.05	0.25
Nickel (mg/L)	NA	NA	<0.005	<0.005	<0.005	<0.005
Aluminum (mg/L)	NA	NA	<0.5	<0.5	<0.5	<0.5
Copper (mg/L)	NA	NA	0.003	0.002	<0.001	0.003
Zinc (mg/L)	NA	NA	<0.02	<0.02	<0.02	<0.02
Manganese (mg/L)	NA	NA	<0.02	<0.10	0.03	0.42
Mercury (filtered) (µg/L)	<0.2	<.2	<0.2	<0.2	<0.2	<0.2
Total Organic Carbon (mg/L)	6	7	8	13	7	8
Total Inorganic Carbon (mg/L)	5	5	5	6	5	7
Chloride (mg/L)	1.7	0.5	0.4	4.3	0.4	0.6
Potassium (mg/L)	NA	NA	0.34	0.40	0.39	0.46
Total Phosphorus (mg/L)	NA	NA	0.011	0.026	<0.003	0.020
Soluble Phosphorus (mg/L)	NA	NA	0.008	0.020	<0.003	<0.003
Total Phosphate (as P) (mg/L)	0.016	0.020	NA	NA	NA	NA
Soluble Phosphate (as P) (mg/L)	<0.010	0.010	NA	NA	NA	NA
Total Kjeldahl Nitrogen (mg/L)	0.10	0.15	0.10	0.10	0.09	0.13
Nitrate (NO_3) (mg/L)	<0.1	<0.1	2.5	1.7	0.01	0.01
Total Silica (mg/L)	5.0	2.3	1.7	2.6	1.2	2.7
Soluble Silica (mg/L)	0.66	0.84	1.10	2.30	1.00	2.40
Ammonia (NH_3) (mg/L)	<0.01	0.06	0.02	0.03	<0.01	0.01
Arsenic (mg/L)	NA	NA	<0.001	<0.001	<0.002	<0.002
Selenium (mg/L)	NA	NA	<0.002	<0.002	<0.001	<0.001

[1] Surface to Bottom Sample
NA - Not Analyzed

APPENDIX 3 (cont'd)

WATER CHEMISTRY - MARMION SOUTH - ATIKOKAN 1982

Parameter	May		August		October	
	Surface	Bottom	Surface	Bottom	Surface	Bottom
Turbidity (NTU)	1.7	2.1	0.4	0.5	0.8	0.8
Specific Conductance (mS/m)	9.5	10.0	7.6	8.4	9.7	10
Non-filtrable 105°C (mg/L)	1.8	2.6	2.5	2.5	<2.0	<2.0
Residues 550°C (mg/L)	<0.5	1.0	2.0	1.5	<2.0	<2.0
Filtrable 105°C (mg/L)	60	62	68	80	70	74
Residues 550°C (mg/L)	37	44	48	59	48	51
Colour	None	None	None	None	None	None
pH	6.8	6.4	7.3	6.9	7.4	7.2
Alkalinity (HCO_3 as $CaCO_3$) (mg/L)	(36)[1]		(32)[1]		(32)[1]	
Hardness ($CaCO_3$) (mg/L)	NA	NA	38	41	42	42
Calcium (mg/L)	NA	NA	11	12	12	12
Magnesium (mg/L)	NA	NA	2.6	2.8	2.9	3.0
Sodium (mg/L)	NA	NA	2.0	2.2	2.2	2.0
Sulphate (SO_4) (mg/L)	7.3	8.2	8.3	8.3	6.9	7.2
Suspended Iron (mg/L)	42	47	44	48	43	38
Dissolved Iron (mg/L)	NA	NA	<0.05	0.05	<0.05	<0.05
Nickel (mg/L)	NA	NA	<0.005	<0.005	<0.005	<0.005
Aluminum (mg/L)	NA	NA	<0.5	<0.5	<0.5	<0.5
Copper (mg/L)	NA	NA	0.003	0.004	<0.001	<0.001
Zinc (mg/L)	NA	NA	<0.02	<0.02	<0.02	<0.02
Manganese (mg/L)	NA	NA	0.03	0.08	0.04	0.05
Mercury (filtered) (µg/L)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Total Organic Carbon (mg/L)	8	8	9	10	9	9
Total Inorganic Carbon (mg/L)	7	6	7	8	6	6
Chloride (mg/L)	2.2	2.4	1.6	2.0	1.6	2.5
Potassium (mg/L)	NA	NA	0.63	0.68	0.72	0.72
Total Phosphorus (mg/L)	NA	NA	0.013	0.016	<0.003	0.003
Soluble Phosphorus (mg/L)	NA	NA	0.004	0.012	<0.003	<0.003
Total Phosphate (as P) (mg/L)	0.019	0.022	NA	NA	NA	NA
Soluble Phosphate (as P) (mg/L)	0.010	<0.010	NA	NA	NA	NA
Total Kjeldahl Nitrogen (mg/L)	0.11	0.15	0.11	0.12	0.15	0.15
Nitrate (NO_3) (mg/L)	<0.10	<0.10	2.80	1.30	0.07	0.03
Total Silica (mg/L)	3.2	3.3	2.2	4.8	3.3	2.2
Soluble Silica (mg/L)	1.4	1.5	2.2	2.4	2.7	1.8
Ammonia (NH_3) (mg/L)	<0.01	0.03	0.01	0.01	0.02	0.02
Arsenic (mg/L)	NA	NA	<0.001	<0.001	<0.002	<0.002
Selenium (mg/L)	NA	NA	<0.002	<0.002	<0.001	<0.001

[1] Surface to Bottom Sample
NA - Not Analyzed

APPENDIX 3 (cont'd)

WATER CHEMISTRY - MARMION NORTH - ATIKOKAN 1982

Parameter	May		August		October	
	Surface	Bottom	Surface	Bottom	Surface	Bottom
Turbidity (NTU)	1.5	1.7	0.5	0.5	1.0	0.9
Specific Conductance (mS/m)	6.5	6.8	7.0	7.2	9.1	9.1
Non-filtrable 105°C (mg/L)	1.6	3.0	2.5	<1.0	<2.0	<2.0
Residues 550°C (mg/L)	<0.5	1.0	2.5	<1.0	<2.0	<2.0
Filtrable 105°C (mg/L)	45	46	66	70	89	63
Residues 550°C (mg/L)	20	22	48	50	68	51
Colour	None	None	None	None	None	None
pH	6.6	6.5	7.0	7.1	7.4	7.3
Alkalinity (HCO_3 as $CaCO_3$) (mg/L)	(24)[1]		(28)[1]		(30)[1]	
Hardness ($CaCO_3$) (mg/L)	NA	NA	37	38	39	46
Calcium (mg/L)	NA	NA	11	11	11	12
Magnesium (mg/L)	NA	NA	2.4	2.5	2.8	3.6
Sodium (mg/L)	NA	NA	1.8	1.9	1.9	1.9
Sulphate (SO_4) (mg/L)	6.0	5.7	8.0	7.1	7.0	7.2
Suspended Iron (mg/L)	40	48	61	77	35	65
Dissolved Iron (mg/L)	NA	NA	0.07	0.13	0.05	0.05
Nickel (mg/L)	NA	NA	<0.005	<0.005	<0.005	<0.005
Aluminum (mg/L)	NA	NA	<0.5	<0.5	<0.5	<0.5
Copper (mg/L)	NA	NA	0.010	0.006	0.002	0.001
Zinc (mg/L)	NA	NA	<0.02	<0.02	<0.02	<0.02
Manganese (mg/L)	NA	NA	0.04	0.17	0.07	0.08
Mercury (filtered) (µg/L)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Total Organic Carbon (mg/L)	8	8	11	11	8	8
Total Inorganic Carbon (mg/L)	5	6	7	7	6	6
Chloride (mg/L)	1.5	1.4	1.7	1.3	1.5	1.5
Potassium (mg/L)	NA	NA	0.60	0.63	0.69	0.72
Total Phosphorus (mg/L)	NA	NA	0.015	0.022	<0.003	0.008
Soluble Phosphorus (mg/L)	NA	NA	0.006	0.017	<0.003	<0.003
Total Phosphate (as P) (mg/L)	0.011	0.015	NA	NA	NA	
Soluble Phosphate (as P) (mg/L)	0.010	<0.010	NA	NA	NA	
Total Kjeldahl Nitrogen (mg/L)	0.10	0.10		0.12	0.16	0.14
Nitrate (NO_3) (mg/L)	<0.10	<0.10	0.23	1.20	0.04	0.05
Total Silica (mg/L)	3.1	4.4	3.3	4.9	3.2	3.6
Soluble Silica (mg/L)	1.7	1.8	2.6	3.3	2.1	2.0
Ammonia (NH_3) (mg/L)	<0.01	0.01	0.08	0.02	0.02	0.02
Arsenic (mg/L)	NA	NA	<0.001	<0.001	<0.002	<0.002
Selenium (mg/L)	NA	NA	<0.002	<0.002	<0.001	<0.001

[1] Surface to Bottom Sample
NA - Not Analyzed

APPENDIX 3 (cont'd)

WATER CHEMISTRY - ANDERSON DAM - ATIKOKAN 1982

Parameter	May		August		October	
	Surface	Bottom	Surface	Bottom	Surface	Bottom
Turbidity (NTU)	1.5	1.6	0.9	0.9	2.3	2.0
Specific Conductance (mS/m)	11.1	11.1	9.1	9.0	10.5	10.3
Non-filtrable 105°C (mg/L)	3.0	4.0	3.0	3.5	4.0	2.0
Residues 550°C (mg/L)	1.0	1.8	1.5	2.0	<2.0	<2.0
Filtrable 105°C (mg/L)	64	64	64	71	65	77
Residues 550°C (mg/L)	43	42	42	50	57	56
Colour	None	None	None	None	None	None
pH	6.9	6.8	7.1	7.2	7.5	7.5
Alkalinity (HCO_3 as $CaCO_3$) (mg/L)	(38)[1]		(34)[1]		(35)[1]	
Hardness ($CaCO_3$) (mg/L)	NA	NA	42	NA	46	47
Calcium (mg/L)	NA	NA	12	NA	13	13
Magnesium (mg/L)	NA	NA	3.0	NA	3.4	3.5
Sodium (mg/L)	NA	NA	2.2	NA	2.1	2.1
Sulphate (SO_4) (mg/L)	13	12	9.6	9.7	9.0	9.0
Suspended Iron (mg/L)	48	78	108	136	207	215
Dissolved Iron (mg/L)	NA	NA	0.10	NA	0.16	0.17
Nickel (mg/L)	NA	NA	<0.005	NA	<0.005	<0.005
Aluminum (mg/L)	NA	NA	<0.5	NA	<0.5	<0.5
Copper (mg/L)	NA	NA	0.005	NA	0.001	0.002
Zinc (mg/L)	NA	NA	<0.02	NA	<0.02	<0.02
Manganese (mg/L)	NA	NA	0.03	NA	0.03	0.03
Mercury (filtered) (µg/L)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Total Organic Carbon (mg/L)	5	5	9	9	8	8
Total Inorganic Carbon (mg/L)	10	10	8	8	7	7
Chloride (mg/L)	2.1	2.1	1.7	1.7	1.8	1.7
Potassium (mg/L)	NA	NA	0.71	NA	0.80	0.80
Total Phosphorus (mg/L)	NA	NA	0.024	0.029	0.009	0.010
Soluble Phosphorus (mg/L)	NA	NA	0.005	0.023	0.005	<0.009
Total Phosphate (as P) (mg/L)	0.013	0.019	NA	NA	NA	NA
Soluble Phosphate (as P) (mg/L)	0.010	<0.010	NA	NA	NA	NA
Total Kjeldahl Nitrogen (mg/L)	0.10	0.15	0.12	0.13	0.13	0.14
Nitrate (NO_3) (mg/L)	<0.10	<0.10	0.27	2.80	0.03	0.02
Total Silica (mg/L)	3.7	4.1	3.3	4.2	4.8	4.0
Soluble Silica (mg/L)	1.5	1.2	2.9	1.9	3.1	2.3
Ammonia (NH_3) (mg/L)	<0.01	<0.01	0.01	0.02	0.02	0.03
Arsenic (mg/L)	NA	NA	0.002	NA	<0.002	<0.002
Selenium (mg/L)	NA	NA	0.002	NA	<0.001	<0.001

[1] Surface to Bottom Sample
NA - Not Analyzed

APPENDIX 4

DENSITIES (mg/m^3) OF PHYTOPLANKTON IN ATIKOKAN GS PREOPERATIONAL STUDY LAKES - 1982

AB - Abie Lake
AD - Anderson Dam
IC - Icy Lake
MN - Marmion North
MS - Marmion South
SL - Snow Lake
SLU - Slush Lake

Appendix 4
Phytoplankton Atikokan GS Preoperational Study 1982

date = 05

Species Name	AKAB N= 1	%	AKAD N= 1	%	AKIC N= 1	%
RHODOMONAS MINUTA	525.8	61	283.8	59	433.4	57
CYCLOTELLA SP	40.5	5	94.5	20	11.7	2
CRYPTOMONAS SP	20.8	2	10.56	2	56	7
MELOSIRA SP	32.62	4	0	0	0	0
SYNEDRA SP	80	9	20	4	17	2
PENNALES	23	3	20	4	80	11
PERIDINIUM SP	33.2	4	0	0	32.8	4
CRYPTOPHYTA TYPE 1	13.2	2	6.6	1	15.4	2
MICROCYSTIS SP	28.16	3	15.36	3	11.2	1
DINOBRYON SOCIALE	11.4	1	7.6	2	39.9	5
DIATOMA SP	0	0	0	0	0	0
ASTERIONELLA GRACILLIMA	0	0	0	0	6.4	1
CHROOCOCCUS SP	28.8	3	0	0	31.4	4
ASTERIONELLA FORMOSA	0	0	0	0	0	0
ANKISTRODESMUS FALCATUS	9	1	0	0	1.5	0
DINOBRYON SP	3.8	0	0	0	0	0
TETRAEDRON SP	9.5	1	9.5	2	9.5	1
APHANIZOMENON FLOS-AQUAE	0	0	2.64	1	8.25	1
MALLOMONAS SP	0	0	0	0	0	0
SCENEDESMUS BIJUGA	.8	0	.8	0	3.2	0
ANKISTRODESMUS FALCATUS VAR MIRABILIS	0	0	0	0	0	0
GOLENKINIA SP	0	0	0	0	0	0
OOCYSTIS SP	0	0	0	0	0	0
CYMBELLA SP	0	0	0	0	0	0
SELENASTRUM SP	0	0	6	1	0	0
LAGERHEIMIA QUADRISETA	0	0	0	0	0	0
ANABAENA SP	2.6	0	0	0	0	0
ELAKATOTHRIX GELATINOSA	0	0	0	0	0	0
LAGERHEIMIA SP	0	0	0	0	0	0
totals	863.18	100	477.36	100	757.65	100

Appendix 4
Phytoplankton Atikokan GS Preoperational Study 1982

Species Name	AKMN N= 1	%	AKMS N= 1	%	AKSL N= 1	%
RHODOMONAS MINUTA	160.6	38	237.6	37	208.8	39
CYCLOTELLA SP	54	13	90	14	54	10
CRYPTOMONAS SP	42.24	10	77.44	12	20.8	4
MELOSIRA SP	13.98	3	93.2	14	18.64	4
SYNEDRA SP	19	5	60	9	27	5
PENNALES	20	5	20	3	17	3
PERIDINIUM SP	0	0	0	0	33.2	6
CRYPTOPHYTA TYPE 1	22	5	13.2	2	28.6	5
MICROCYSTIS SP	0	0	8.64	1	19.2	4
DINOBRYON SOCIALE	1.9	0	7.6	1	7.6	1
DIATOMA SP	67.5	16	0	0	0	0
ASTERIONELLA GRACILLIMA	0	0	0	0	57.6	11
CHROOCOCCUS SP	0	0	0	0	0	0
ASTERIONELLA FORMOSA	0	0	0	0	0	0
ANKISTRODESMUS FALCATUS	3	1	3	0	4.5	1
DINOBRYON SP	0	0	0	0	22.8	4
TETRAEDRON SP	0	0	0	0	0	0
APHANIZOMENON FLOS-AQUAE	0	0	0	0	5.61	1
KALLOMONAS SP	0	0	20.4	3	0	0
SCENEDESMUS BIJUGA	0	0	2.4	0	8.8	2
ANKISTRODESMUS FALCATUS VAR MIRABILIS	1.6	0	0	0	0	0
GOLENKINIA SP	12.9	3	0	0	0	0
OOCYSTIS SP	0	0	0	0	0	0
CYMBELLA SP	0	0	10	2	0	0
SELENASTRUM SP	0	0	0	0	0	0
LAGERHEIMIA QUADRISETA	.7	0	0	0	0	0
ANABAENA SP	0	0	0	0	0	0
ELAKATOTHRIX GELATINOSA	0	0	0	0	0	0
LAGERHEIMIA SP	0	0	0	0	0	0
totals	419.42	100	643.48	100	532.15	100

Appendix 4
Phytoplankton Atikokan GS Preoperational Study 1982

Species Name	AKSLU N= 1	%	mean	%
RHODOMONAS MINUTA	162.8	24	287.257143	46
CYCLOTELLA SP	14.4	2	51.3	8
CRYPTOMONAS SP	98.56	14	46.6285715	7
MELOSIRA SP	163.1	24	45.9342858	7
SYNEDRA SP	60	9	40.4285715	6
PENNALES	10	1	27.1428572	4
PERIDINIUM SP	49.8	7	21.2857143	3
CRYPTOPHYTA TYPE 1	28.6	4	18.2285714	3
MICROCYSTIS SP	0	0	11.7942857	2
DINOBRYON SOCIALE	3.8	1	11.4	2
DIATOMA SP	0	0	9.64285714	2
ASTERIONELLA GRACILLIMA	0	0	9.14285714	1
CHROOCOCCUS SP	0	0	8.6	1
ASTERIONELLA FORMOSA	41.4	6	5.91428572	1
ANKISTRODESMUS FALCATUS	10.5	2	4.5	1
DINOBRYON SP	3.8	1	4.34285715	1
TETRAEDRON SP	0	0	4.07142858	1
APHANIZOMENON FLOS-AQUAE	11.253	2	3.96471429	1
KALLOMONAS SP	0	0	2.91428572	0
SCENEDESMUS BIJUGA	0	0	2.28571429	0
ANKISTRODESMUS FALCATUS VAR MIRABILIS	14.4	2	2.28571429	0
GOLENKINIA SP	0	0	1.84285714	0
OOCYSTIS SP	10	1	1.42857143	0
CYMBELLA SP	0	0	1.42857143	0
SELENASTRUM SP	0	0	.857142858	0
LAGERHEIMIA QUADRISETA	3.15	0	.55	0
ANABAENA SP	0	0	.371428572	0
ELAKATOTHRIX GELATINOSA	2	0	.285714286	0
LAGERHEIMIA SP	1.2	0	.171428571	0
totals	688.763	100	626.000429	100

Appendix 4
Phytoplankton Atikokan GS Preoperational Study 1982

date = 08

Species Name	AKAB N= 1	%	AKAD N= 1	%	AKIC N= 1	%
ANABAENA SP	15.6	4	0	0	20.8	7
RHODOMONAS MINUTA	52.8	15	231	62	55	18
MICROCYSTIS SP	4.8	1	17.6	5	46.4	15
CRYPTOMONAS SP	17.6	5	14.08	4	70.4	23
TABELLARIA SP	80	22	0	0	0	0
MELOSIRA SP	69.9	20	16.31	4	0	0
APHANIZOMENON FLOS-AQUAE	16.5	5	8.58	2	36.3	12
CYCLOTELLA SP	18	5	9	2	9	3
CRYPTOPHYTA TYPE 1	8.8	2	17.6	5	11	4
CHROOCOCCUS SP	0	0	25.2	7	0	0
RHIZOSOLENIA SP	0	0	0	0	0	0
ASTERIONELLA GRACILLIMA	0	0	0	0	0	0
PENNALES	0	0	20	5	0	0
LYNGBYA SP	60	17	0	0	0	0
TETRAEDRON SP	0	0	9.5	3	0	0
CLOSTERIUM SP	0	0	0	0	0	0
SYNEDRA SP	0	0	0	0	0	0
OSCILLATORIA SPP	0	0	0	0	39	13
OOCYSTIS SP	0	0	0	0	10	3
DINOBRYON SP	9.5	3	3.8	1	0	0
FRAGILARIA CROTONENSIS	0	0	0	0	6.4	2
ELAKATOTHRIX GELATINOSA	3	1	2	1	0	0
SCENEDESMUS BIJUGA	1.6	0	0	0	1.6	1
MERISMOPEDIA SP	0	0	0	0	0	0
SPONDYLOSIUM SP	0	0	0	0	0	0
ANKISTRODESMUS FALCATUS	0	0	0	0	1.5	0
CRUCIGENIA SP	0	0	0	0	0	0
ANKISTRODESMUS FALCATUS VAR MIRABILIS	0	0	.2	0	0	0
SCHROEDERIA SETIGERA	0	0	0	0	0	0
totals	358.1	100	374.87	100	307.4	100

Appendix 4

Phytoplankton Atikokan GS Preoperational Study 1982

Species Name	AKMN N= 1	%	AKMS N= 1	%	AKSL N= 1	%
ANABAENA SP	6.5	3	27.3	5	785.2	56
RHODOMONAS MINUTA	74.8	36	85.8	16	101.2	7
MICROCYSTIS SP	19.2	9	14.4	3	98.4	7
CRYPTOMONAS SP	17.6	9	35.2	7	28.16	2
TABELLARIA SP	40	19	40	8	0	0
MELOSIRA SP	0	0	93.2	18	0	0
APHANIZOMENON FLOS-AQUAE	25.41	12	27.72	5	30.03	2
CYCLOTELLA SP	13.5	7	22.5	4	13.05	1
CRYPTOPHYTA TYPE 1	8.8	4	13.2	3	22	2
CHROOCOCCUS SP	0	0	30.6	6	36	3
RHIZOSOLENIA SP	0	0	30	6	60	4
ASTERIONELLA GRACILLIMA	0	0	64	12	14.72	1
PENNALES	0	0	0	0	50	4
LYNGBYA SP	0	0	0	0	0	0
TETRAEDRON SP	0	0	0	0	47.5	3
CLOSTERIUM SP	0	0	0	0	46	3
SYNEDRA SP	0	0	0	0	40	3
OSCILLATORIA SPP	0	0	0	0	0	0
OOCYSTIS SP	0	0	10	2	12.5	1
DINOBRYON SP	0	0	3.8	1	0	0
FRAGILARIA CROTONENSIS	0	0	19.2	4	0	0
ELAKATOTHRIX GELATINOSA	0	0	3	1	16	1
SCENEDESMUS BIJUGA	.8	0	0	0	4.8	0
MERISMOPEDIA SP	0	0	0	0	0	0
SPONDYLOSIUM SP	0	0	0	0	0	0
ANKISTRODESMUS FALCATUS	0	0	0	0	0	0
CRUCIGENIA SP	0	0	0	0	1.4	0
ANKISTRODESMUS FALCATUS VAR MIRABILIS	0	0	.2	0	0	0
SCHROEDERIA SETIGERA	0	0	0	0	.4	0
totals	206.61	100	520.12	100	1407.36	100

Appendix 4
Phytoplankton Atikokan GS Preoperational Study 1982

Species Name	AKSLU N= 1	%	mean	%	
ANABAENA SP	0	0	122.2	25	
RHODOMONAS MINUTA	77	36	96.8	20	
MICROCYSTIS SP	20.8	10	31.6571429	7	
CRYPTOMONAS SP	14.08	7	28.16	6	
TABELLARIA SP	20	9	25.7142857	5	
MELOSIRA SP	0	0	25.63	5	
APHANIZOMENON FLOS-AQUAE	0	0	20.6485714	4	
CYCLOTELLA SP	40.5	19	17.9357143	4	
CRYPTOPHYTA TYPE 1	22	10	14.7714286	3	
CHROOCOCCUS SP	0	0	13.1142857	3	
RHIZOSOLENIA SP	0	0	12.8571429	3	
ASTERIONELLA GRACILLIMA	0	0	11.2457143	2	
PENNALES	0	0	10	2	
LYNGBYA SP	0	0	8.57142858	2	
TETRAEDRON SP	0	0	8.14285715	2	
CLOSTERIUM SP	0	0	6.57142858	1	
SYNEDRA SP	0	0	5.71428572	1	
OSCILLATORIA SPP	0	0	5.57142858	1	
OOCYSTIS SP	0	0	4.64285715	1	
DINOBRYON SP	9.5	4	3.8	1	
FRAGILARIA CROTONENSIS	0	0	3.65714286	1	
ELAKATOTHRIX GELATINOSA	0	0	3.42857143	1	
SCENEDESMUS BIJUGA	0	0	1.25714286	0	
MERISMOPEDIA SP	6.16	3	.88	0	
SPONDYLOSIUM SP	4	2	.571428571	0	
ANKISTRODESMUS FALCATUS	0	0	.214285714	0	
CRUCIGENIA SP	0	0	.2	0	
ANKISTRODESMUS FALCATUS VAR MIRABILIS	.2	0	.0857142858		0
SCHROEDERIA SETIGERA	0	0	.0571428572		0
totals	214.24	100	484.1	100	

Appendix 4
Phytoplankton Atikokan GS Preoperational Study 1982

date = 10

Species Name	AKAB N= 1	%	AKAD N= 1	%	AKIC N= 1	%
RHODOMONAS MINUTA	37.4	18	72.6	9	99	25
STEPHANODISCUS NIAGARAE	0	0	414.8	54	0	0
CRYPTOMONAS SP	17.6	9	70.4	9	28.16	7
APHANIZOMENON FLOS-AQUAE	36.3	18	47.85	6	36.96	9
MELOSIRA SP	25.63	13	32.62	4	30.29	8
PENNALES	0	0	10	1	30	7
ANABAENA SP	0	0	29.9	4	22.1	6
TABELLARIA SP	10	5	0	0	80	20
CRYPTOPHYTA TYPE 1	28.6	14	6.6	1	15.4	4
ASTERIONELLA GRACILLIMA	0	0	12.8	2	0	0
DINOBRYON SOCIALE	22.8	11	3.8	0	19	5
TETRAEDRON SP	0	0	38	5	0	0
COSMARIUM SP	0	0	0	0	0	0
RHIZOSOLENIA SP	0	0	0	0	0	0
CYCLOTELLA SP	9	4	22.5	3	4.5	1
GLOEOCYSTIS SP	0	0	0	0	0	0
SYNEDRA SP	0	0	0	0	10	2
DINOBRYON SP	5.7	3	3.8	0	3.8	1
MICROCYSTIS SP	0	0	0	0	12	3
SCENEDESMUS BIJUGA	1.6	1	3.2	0	2	0
ELAKATOTHRIX GELATINOSA	4	2	0	0	7	2
CYMBELLA SP	0	0	0	0	0	0
UNIDENTIFIED 2	0	0	0	0	0	0
OOCYSTIS SP	0	0	0	0	0	0
FRAGILARIA SP	4.5	2	0	0	0	0
STEPHANODISCUS SP	0	0	0	0	0	0
ANKISTRODESMUS FALCATUS VAR MIRABILIS	0	0	0	0	0	0
totals	203.13	100	768.87	100	400.21	100

Appendix 4
Phytoplankton Atikokan SS Preoperational Study 1982

Species Name	AKMN N= 1	%	AKMS N= 1	%	AKSL N= 1	%
RHODOMONAS MINUTA	52.8	22	57.2	27	154	34
STEPHANODISCUS NIAGARAE	0	0	0	0	0	0
CRYPTOMONAS SP	52.8	22	10.56	5	45.76	10
APHANIZOMENON FLOS-AQUAE	4.785	2	13.86	6	0	0
MELOSIRA SP	22.135	9	18.83	9	11.65	3
PENNALES	25	11	20	9	50	11
ANABAENA SP	23.4	10	27.3	13	0	0
TABELLARIA SP	10	4	0	0	0	0
CRYPTOPHYTA TYPE 1	14.3	6	8.8	4	22	5
ASTERIONELLA GRACILLIMA	12.8	5	25.6	12	26.8	6
DINOBRYON SOCIALE	8.55	4	5.7	3	3.8	1
TETRAEDRON SP	0	0	0	0	38	8
COSMARIUM SP	0	0	0	0	0	0
RHIZOSOLENIA SP	0	0	0	0	60	13
CYCLOTELLA SP	6.75	3	0	0	4.5	1
GLOEOCYSTIS SP	0	0	0	0	0	0
SYNEDRA SP	0	0	0	0	20	4
DINOBRYON SP	2.85	1	3.8	2	0	0
MICROCYSTIS SP	0	0	0	0	8	2
SCENEDESMUS BIJUGA	.4	0	.8	0	2.4	1
ELAKATOTHRIX GELATINOSA	1	0	0	0	0	0
CYMBELLA SP	0	0	10	5	0	0
UNIDENTIFIED 2	0	0	10	5	0	0
OOCYSTIS SP	0	0	0	0	0	0
FRAGILARIA SP	0	0	0	0	0	0
STEPHANODISCUS SP	0	0	.85	0	0	0
ANKISTRODESMUS FALCATUS VAR MIRABILIS	0	0	0	0	0	0
totals	237.57	100	213.3	100	448.91	100

Appendix 4

Phytoplankton Atikokan GS Preoperational Study 1982

Species Name	AKSLU N= 1	%	mean	%	
RHODOMONAS MINUTA	39.6	12	73.2285714	20	
STEPHANODISCUS NIAGARAE	0	0	59.2571429	16	
CRYPTOMONAS SP	70.4	21	42.24	11	
APHANIZOMENON FLOS-AQUAE	51.15	15	27.2721429	7	
MELOSIRA SP	0	0	20.165	5	
PENNALES	0	0	19.2857143	5	
ANABAENA SP	22.1	6	17.8285714	5	
TABELLARIA SP	20	6	17.1428572	5	
CRYPTOPHYTA TYPE 1	4.4	1	14.3	4	
ASTERIONELLA GRACILLIMA	6.4	2	12.3428571	3	
DINOBRYON SOCIALE	17.1	5	11.5357143	3	
TETRAEDRON SP	0	0	10.8571429	3	
COSMARIUM SP	66	19	9.42857143	3	
RHIZOSOLENIA SP	0	0	8.57142858	2	
CYCLOTELLA SP	0	0	6.75	2	
GLOEOCYSTIS SP	34.96	10	4.99428572	1	
SYNEDRA SP	0	0	4.28571429	1	
DINOBRYON SP	3.8	1	3.39285715	1	
MICROCYSTIS SP	0	0	2.85714286	1	
SCENEDESMUS BIJUGA	1.6	0	1.71428572	0	
ELAKATOTHRIX GELATINOSA	0	0	1.71428572	0	
CYMBELLA SP	0	0	1.42857143	0	
UNIDENTIFIED 2	0	0	1.42857143	0	
OOCYSTIS SP	5	1	.714285715	0	
FRAGILARIA SP	0	0	.642857143	0	
STEPHANODISCUS SP	0	0	.121428571	0	
ANKISTRODESMUS FALCATUS VAR MIRABILIS	.4	0	.0571428572		0
totals	342.91	100	373.557143	100	

APPENDIX 5

DENSITIES (No/m^3) OF ZOOPLANKTON IN
ATIKOKAN GS PREOPERATIONAL STUDY LAKES - 1982

AB - Abie Lake
AD - Anderson Dam
IC - Icy Lake
MN - Marmion North
MS - Marmion South
SL - Snow Lake
SLU - Slush Lake

Appendix 5
Zooplankton Atikokan GS Preoperational Study 1982

date = May

Species Name	AKAB N= 1	%	AKAD N= 1	%	AKIC N= 1	%
KERATELLA COCHLEARIS	16650	27	10551	22	9070	11
KELLICOTTIA LONGISPINA	0	0	4072	9	26284	33
CYCLOPOIDA NAUPLIAR STAGES	8144	13	6849	14	6108	8
POLYARTHRA SPP	3702	6	0	0	5183	7
CYCLOPOIDA COPEPODITE STAGES	2591	4	7219	15	3517	4
ASPLANCHNA SPP	4072	7	3887	8	7589	10
CALANOIDA NAUPLIAR STAGES	3687	6	2777	6	2591	3
GASTROPUS SPP	4626	8	2221	5	2221	3
CYCLOPS BICUSPIDATUS THOMASI	3692	6	1721	4	4257	5
KERATELLA QUADRATA	1666	3	925	2	7786	10
ASPLANCHNA PRIODONTA	2962	5	1666	4	1111	1
KERATELLA HIEMALIS	555	1	185	0	1666	2
SYNCHAETA SPP	4442	7	555	1	185	0
CALANOIDA COPEPODITE STAGES	1111	2	1111	2	926	1
DIAPTOMUS OREGONENSIS	185	0	926	2	555	1
MESOCYCLOPS EDAX	1296	2	370	1	0	0
FILINIA LONGISETA	370	1	555	1	0	0
BOSMINA LONGIROSTRIS	185	0	741	2	0	0
TRICHOCERCA SPP	0	0	0	0	0	0
DAPHNIA LONGIREMIS	555	1	0	0	0	0
UNIDENTIFIED ROTIFER	0	0	0	0	0	0
NOTHOLCA SQUAMULA	185	0	0	0	0	0
NOTHOLCA FOLIACEA	0	0	0	0	370	0
LEPADELLA SPP	0	0	0	0	0	0
DAPHNIA GALEATA MENDOTAE	0	0	370	1	0	0
DIAPTOMUS MINUTUS	0	0	370	1	0	0
DAPHNIA SPP	0	0	185	0	0	0
TRICHOTRIA TETRACTIS	185	0	0	0	0	0
LECANE LUNARIS	185	0	0	0	0	0
DAPHNIA PARVULA	185	0	0	0	0	0
BRACHIONUS CALYCIFLORUS	0	0	0	0	0	0
TRICHOCERCA LONGISETA	0	0	0	0	0	0
BRACHIONUS SPP	0	0	0	0	0	0
totals	61231	100	47256	100	79419	100

Appendix 5
Zooplankton Atikokan GS Preoperational Study 1982

Species Name	AKMN N= 1	%	AKMS N= 1	%	AKSL N= 1	%
KERATELLA COCHLEARIS	7421	20	13513	21	22398	30
KELLICOTTIA LONGISPINA	695	2	7590	12	13637	18
CYCLOPOIDA NAUPLIAR STAGES	3899	10	10181	16	6479	9
POLYARTHRA SPP	14585	39	3147	5	2591	3
CYCLOPOIDA COPEPODITE STAGES	1667	4	5183	8	4813	6
ASPLANCHNA SPP	2848	8	4628	7	2221	3
CALANOIDA NAUPLIAR STAGES	1389	4	4072	6	2777	4
GASTROPUS SPP	764	2	3332	5	6479	9
CYCLOPS BICUSPIDATUS THOMASI	764	2	3517	5	3702	5
KERATELLA QUADRATA	278	1	555	1	925	1
ASPLANCHNA PRIODONTA	972	3	1296	2	3887	5
KERATELLA HIEMALIS	139	0	0	0	0	0
SYNCHAETA SPP	625	2	1296	2	740	1
CALANOIDA COPEPODITE STAGES	347	1	1296	2	1296	2
DIAPTOMUS OREGONENSIS	347	1	3888	6	926	1
MESOCYCLOPS EDAX	347	1	555	1	370	0
FILINIA LONGISETA	0	0	370	1	370	0
BOSMINA LONGIROSTRIS	0	0	185	0	185	0
TRICHOCERCA SPP	0	0	0	0	555	1
DAPHNIA LONGIREMIS	0	0	0	0	0	0
UNIDENTIFIED ROTIFER	0	0	0	0	370	0
NOTHOLCA SQUAMULA	70	0	0	0	0	0
NOTHOLCA FOLIACEA	0	0	0	0	0	0
LEDABELLA SPP	0	0	0	0	370	0
DAPHNIA GALEATA MENDOTAE	0	0	0	0	0	0
DIAPTOMUS MINUTUS	0	0	0	0	0	0
DAPHNIA SPP	70	0	0	0	0	0
TRICHOTRIA TETRACTIS	0	0	0	0	0	0
LECANE LUNARIS	0	0	0	0	0	0
DAPHNIA PARVULA	0	0	0	0	0	0
BRACHIONUS CALYCIFLORUS	70	0	0	0	0	0
TRICHOCERCA LONGISETA	70	0	0	0	0	0
BRACHIONUS SPP	0	0	0	0	0	0
totals	37357	100	64604	100	75091	100

Appendix 5
Zooplankton Atikokan GS Preoperational Study 1982

Species Name	AKSLU N= 1	%	mean	%
KERATELLA COCHLEARIS	2312	8	11702.1429	21
KELLICOTTIA LONGISPINA	246	1	7503.42857	13
CYCLOPOIDA NAUPLIAR STAGES	5487	19	6733.85714	12
POLYARTHRA SPP	3422	12	4661.42857	8
CYCLOPOIDA COPEPODITE STAGES	3391	11	4054.42857	7
ASPLANCHNA SPP	771	3	3716.57143	7
CALANOIDA NAUPLIAR STAGES	2404	8	2813.85714	5
GASTROPUS SPP	0	0	2806.14286	5
CYCLOPS BICUSPIDATUS THOMASI	247	1	2557.14286	5
KERATELLA QUADRATA	1634	6	1967	3
ASPLANCHNA PRIODONTA	0	0	1699.14286	3
KERATELLA HIEMALIS	7782	26	1475.28571	3
SYNCHAETA SPP	0	0	1120.42857	2
CALANOIDA COPEPODITE STAGES	1295	4	1054.57143	2
DIAPTOMUS OREGONENSIS	123	0	992.857143	2
MESOCYCLOPS EDAX	0	0	419.714286	1
FILINIA LONGISETA	124	0	255.571429	0
BOSMINA LONGIROSTRIS	123	0	202.714286	0
TRICHOCERCA SPP	0	0	79.2857143	0
DAPHNIA LONGIREMIS	0	0	79.2857143	0
UNIDENTIFIED ROTIFER	62	0	61.7142857	0
NOTHOLCA SQUAMULA	123	0	54	0
NOTHOLCA FOLIACEA	0	0	52.8571429	0
LEDADELLA SPP	0	0	52.8571429	0
DAPHNIA GALEATA MENDOTAE	0	0	52.8571429	0
DIAPTOMUS MINUTUS	0	0	52.8571429	0
DAPHNIA SPP	0	0	36.4285715	0
TRICHOTRIA TETRACTIS	0	0	26.4285714	0
LECANE LUNARIS	0	0	26.4285714	0
DAPHNIA PARVULA	0	0	26.4285714	0
BRACHIONUS CALYCIFLORUS	0	0	10	0
TRICHOCERCA LONGISETA	0	0	10	0
BRACHIONUS SPP	31	0	4.42857143	0
totals	29577	100	56362.1429	100

Appendix 5
Zooplankton Atikokan GS Preoperational Study 1982

date = Aug

Species Name	AKAB N= 1	%	AKAD N= 1	%	AKIC N= 1	%
KERATELLA COCHLEARIS	35550	31	17550	12	370	1
CYCLOPOIDA NAUPLIAR STAGES	14400	13	23850	17	5555	8
POLYARTHRA SPP	11250	10	17100	12	1630	2
CALANOIDA NAUPLIAR STAGES	5850	5	9450	7	1110	2
DRACHIONUS CALYCIFLORUS	0	0	0	0	27215	39
KELLICOTTIA LONGISPINA	2700	2	5850	4	2590	4
ASPLANCHNA SPP	6750	6	6300	4	6110	9
CYCLOPS BICUSPIDATUS THOMASI	3150	3	10350	7	1480	2
CYCLOPOIDA COPEPODITE STAGES	1800	2	8550	6	925	1
DIAPTOMUS OREGONENSIS	2250	2	5400	4	2405	3
GASTROPUS SPP	4500	4	6750	5	2590	4
BOSMINA LONGIROSTRIS	1800	2	7650	5	555	1
DAPHNIA GALEATA MENDOTAE	2250	2	1800	1	4255	6
HOLOPEDIUM GIBBERUM	450	0	3150	2	185	0
CONOCHILUS UNICORNIS	4950	4	1800	1	3330	5
DAPHNIA SPP	2250	2	3600	3	370	1
CALANOIDA COPEPODITE STAGES	900	1	2250	2	370	1
DIAPHANOSOMA LEUCHTENBERGIANUM	450	0	450	0	1665	2
TRICHOCERCA CYLINDRICA	1800	2	900	1	2220	3
DAPHNIA LONGIREMIS	2250	2	2700	2	185	0
MESOCYCLOPS EDAX	450	0	900	1	555	1
FILINIA LONGISETA	0	0	0	0	1110	2
SYNCHAETA SPP	2250	2	900	1	185	0
CONOCHILOIDES DOSSUARIUS	0	0	0	0	555	1
DIAPTOMUS MINUTUS	0	0	1350	1	555	1
BRACHIONUS ANGULARIS	2250	2	0	0	0	0
TRICHOCERCA LONGISETA	0	0	0	0	0	0
KERATELLA QUADRATA	450	0	0	0	185	0
BRACHIONUS SPP	900	1	450	0	0	0
CONOCHILUS SPP	0	0	1350	1	0	0
DAPHNIA PARVULA	450	0	0	0	370	1
UNIDENTIFIED ROTIFER	450	0	0	0	185	0
LECANE LUNARIS	0	0	0	0	185	0
LECANE BULA	0	0	900	1	0	0
TRICHOCERCA MULTICRINIS	900	1	0	0	0	0
TRICHOCERCA SPP	0	0	0	0	0	0
ASCOMORPHA SPP	450	0	0	0	185	0
CERIODAPHNIA LACUSTRIS	0	0	0	0	370	1
DIAPTOMUS SICILIS	0	0	0	0	0	0
KERATELLA HIEMALIS	0	0	0	0	0	0
LEDADELLA SPP	0	0	0	0	0	0
CHYDORUS SPHAERICUS	0	0	0	0	0	0
EUBOSMINA COREGONI	0	0	0	0	0	0
PLOESOMA TRIACANTHUM	450	0	0	0	0	0
NOTHOLCA FOLIACEA	0	0	0	0	0	0
DAPHNIA RETROCURVA	0	0	0	0	0	0
CERIODAPHNIA SPP	0	0	0	0	0	0
NOTHOLCA LABIS	0	0	0	0	185	0
PLOESOMA TRUNCATUM	0	0	0	0	185	0
DAPHNIA PULEX	0	0	0	0	185	0
totals	114300	100	141300	100	70110	100

Appendix 5
Zooplankton Atikokan GS Preoperational Study 1982

Species Name	AKMN N= 1	%	AKMS N= 1	%	AKSL N= 1	%
KERATELLA COCHLEARIS	6665	9	9620	18	32840	35
CYCLOPOIDA NAUPLIAR STAGES	20000	27	9615	18	10735	11
POLYARTHRA SPP	15000	20	6905	13	5370	6
CALANOIDA NAUPLIAR STAGES	6390	9	4440	8	11845	13
BRACHIONUS CALYCIFLORUS	0	0	0	0	0	0
KELLICOTTIA LONGISPINA	4720	6	985	2	5925	6
ASPLANCHNA SPP	1110	1	0	0	4070	4
CYCLOPS BICUSPIDATUS THOMASI	1950	3	495	1	1850	2
CYCLOPOIDA COPEPODITE STAGES	2500	3	2220	4	1850	2
DIAPTOMUS OREGONENSIS	2500	3	740	1	4440	5
GASTROPUS SPP	835	1	1480	3	555	1
BOSMINA LONGIROSTRIS	2405	3	985	2	370	0
DAPHNIA GALEATA MENDOTAE	0	0	3700	7	1110	1
BOLOPEDIUM GIBBERUM	3615	5	3205	6	740	1
CONOCHILUS UNICORNIS	0	0	245	0	555	1
DAPHNIA SPP	280	0	245	0	2960	3
CALANOIDA COPEPODITE STAGES	835	1	740	1	2220	2
DIAPHANOSOMA LEUCHTENBERGIANUM	1390	2	740	1	1850	2
TRICHOCERCA CYLINDRICA	1110	1	1480	3	0	0
DAPHNIA LONGIREMIS	0	0	1970	4	0	0
MESOCYCLOPS EDAX	555	1	740	1	740	1
FILINIA LONGISETA	835	1	1230	2	370	0
SYNCHAETA SPP	0	0	0	0	0	0
CONOCHILOIDES DOSSUARIUS	0	0	0	0	1110	1
DIAPTOMUS MINUTUS	0	0	0	0	370	0
BRACHIONUS ANGULARIS	0	0	0	0	0	0
TRICHOCERCA LONGISETA	0	0	245	0	1480	2
KERATELLA QUADRATA	555	1	0	0	0	0
BRACHIONUS SPP	0	0	0	0	0	0
CONOCHILUS SPP	0	0	0	0	0	0
DAPHNIA PARVULA	0	0	495	1	0	0
UNIDENTIFIED ROTIFER	0	0	0	0	370	0
LECANE LUNARIS	0	0	245	0	555	1
LECANE BULA	0	0	0	0	0	0
TRICHOCERCA MULTICRINIS	0	0	0	0	0	0
TRICHOCERCA SPP	280	0	0	0	370	0
ASCOMORPHA SPP	0	0	0	0	0	0
CERIODAPHNIA LACUSTRIS	0	0	245	0	0	0
DIAPTOMUS SICILIS	555	1	0	0	0	0
KERATELLA HIEMALIS	0	0	0	0	0	0
LEBADELLA SPP	0	0	495	1	0	0
CHYDORUS SPHAERICUS	0	0	0	0	0	0
EUBOSMINA COREGONI	0	0	245	0	0	0
PLOESOMA TRIACANTHUM	0	0	0	0	0	0
NOTHOLCA FOLIACEA	0	0	0	0	0	0
DAPHNIA RETROCURVA	0	0	245	0	0	0
CERIODAPHNIA SPP	0	0	0	0	0	0
NOTHOLCA LABIS	0	0	0	0	0	0
PLOESOMA TRUNCATUM	0	0	0	0	0	0
DAPHNIA PULEX	0	0	0	0	0	0
totals	74085	100	53995	100	94650	100

Appendix 5
Zooplankton Atikokan GS Preoperational Study 1982

Species Name	AKSLU N= 1	%	mean	%
KERATELLA COCHLEARIS	11690	20	16326.4286	19
CYCLOPOIDA NAUPLIAR STAGES	10850	19	13572.1429	16
POLYARTHRA SPP	6410	11	9095	10
CALANOIDA NAUPLIAR STAGES	3450	6	6076.42857	7
BRACHIONUS CALYCIFLORUS	0	0	3887.85714	4
KELLICOTTIA LONGISPINA	4195	7	3852.14286	4
ASPLANCHNA SPP	1725	3	3723.57143	4
CYCLOPS BICUSPIDATUS THOMASI	2715	5	3141.42857	4
CYCLOPOIDA COPEPODITE STAGES	3450	6	3042.14286	4
DIAPTOMUS OREGONENSIS	2955	5	2955.71429	3
GASTROPUS SPP	245	0	2422.14286	3
BOSMINA LONGIROSTRIS	985	2	2107.14286	2
DAPHNIA GALEATA MENDOTAE	495	1	1944.28571	2
HOLOPEDIUM GIBBERUM	1230	2	1796.42857	2
CONOCHILUS UNICORNIS	985	2	1695	2
DAPHNIA SPP	0	0	1386.42857	2
CALANOIDA COPEPODITE STAGES	985	2	1185.71429	1
DIAPHANOSOMA LEUCHTENBERGIANUM	1235	2	1111.42857	1
TRICHOCERCA CYLINDRICA	0	0	1072.85714	1
DAPHNIA LONGIREMIS	0	0	1015	1
MESOCYCLOPS EDAX	740	1	668.571429	1
FILINIA LONGISETA	0	0	506.428572	1
SYNCHAETA SPP	0	0	476.428572	1
CONOCHILOIDES DOSSUARIUS	740	1	343.571429	0
DIAPTOMUS MINUTUS	0	0	325	0
BRACHIONUS ANGULARIS	0	0	321.428572	0
TRICHOCERCA LONGISETA	495	1	317.142857	0
KERATELLA QUADRATA	245	0	205	0
BRACHIONUS SPP	0	0	192.857143	0
CONOCHILUS SPP	0	0	192.857143	0
DAPHNIA PARVULA	0	0	187.857143	0
UNIDENTIFIED ROTIFER	245	0	178.571429	0
LECANE LUNARIS	245	0	175.714286	0
LECANE BULA	0	0	128.571429	0
TRICHOCERCA MULTICRINIS	0	0	128.571429	0
TRICHOCERCA SPP	0	0	92.8571429	0
ASCOMORPHA SPP	0	0	90.7142857	0
CERIODAPHNIA LACUSTRIS	0	0	87.8571429	0
DIAPTOMUS SICILIS	0	0	79.2857143	0
KERATELLA HIEMALIS	495	1	70.7142857	0
LEBADELLA SPP	0	0	70.7142857	0
CHYDORUS SPHAERICUS	495	1	70.7142857	0
EUBOSMINA COREGONI	245	0	70	0
PLOESOMA TRIACANTHUM	0	0	64.2857143	0
NOTHOLCA FOLIACEA	245	0	35	0
DAPHNIA RETROCURVA	0	0	35	0
CERIODAPHNIA SPP	245	0	35	0
NOTHOLCA LABIS	0	0	26.4285714	0
PLOESOMA TRUNCATUM	0	0	26.4285714	0
DAPHNIA PULEX	0	0	26.4285714	0
totals	58035	100	86639.2857	100

Appendix 5
Zooplankton Atikokan GS Preoperational Study 1982

date = Oct

Species Name	AKAB N= 1	%	AKAD N= 1	%	AKIC N= 1	%
KERATELLA COCHLEARIS	46350	31	45450	35	71100	57
POLYARTHRA SPP	19575	13	29680	23	11250	9
BOSMINA LONGIROSTRIS	3150	2	14850	11	1575	1
GASTROPUS SPP	16875	11	8325	6	0	0
KELLICOTTIA LONGISPINA	2250	1	6525	5	3600	3
ASPLANCHNA SPP	12150	8	1575	1	5400	4
CALANOIDA NAUPLIAR STAGES	8550	6	4050	3	3825	3
CYCLOPOIDA NAUPLIAR STAGES	6750	4	4950	4	2250	2
CYCLOPS BICUSPIDATUS THOMASI	3375	2	3150	2	2025	2
DAPHNIA GALEATA MENDOTAE	4050	3	2250	2	3600	3
DIAPTOMUS OREGONENSIS	5850	4	2025	2	1575	1
TROCHOSPAREA	12375	8	0	0	0	0
CYCLOPOIDA COPEPODITE STAGES	1575	1	1125	1	1800	1
CONOCHILUS UNICORNIS	900	1	450	0	2700	2
CEPHALODELLA GIBBBA	0	0	0	0	7200	6
DAPHNIA SPP	675	0	1125	1	450	0
DIAPTOMUS MINUTUS	1800	1	1350	1	450	0
SYNCHAETA SPP	1125	1	900	1	450	0
MESOCYCLOPS EDAX	0	0	900	1	1125	1
CALANOIDA COPEPODITE STAGES	450	0	675	1	900	1
DAPHNIA LONGIREMIS	1350	1	0	0	675	1
DAPHNIA RETROCURVA	0	0	0	0	0	0
CONOCHILOIDES BOSSUNARIUS	0	0	0	0	0	0
DEXARTHRA MIRA	0	0	0	0	1350	1
DIAPHANOSOMA LEUCHTENBERGIANUM	0	0	225	0	0	0
CERIODAPHNIA LACUSTRIS	0	0	450	0	0	0
FILINIA LONGISETA	450	0	0	0	0	0
TRICHOCERCA PORCELLUS	0	0	225	0	0	0
HOLOPEDIUM GIBBERUM	0	0	0	0	0	0
LECANE SPP	0	0	225	0	0	0
BRACHIONUS SPP	0	0	0	0	450	0
KERATELLA QUADRATA	0	0	0	0	450	0
PLOESOMA TRUNCATUM	0	0	450	0	0	0
LECANE LUNARIS	0	0	0	0	0	0
UNIDENTIFIED ROTIFER	0	0	0	0	0	0
LECANE LUNA	225	0	0	0	0	0
TRICHOCERCA SPP	0	0	225	0	0	0
TRICHOCERCA CYLINDRICA	0	0	225	0	0	0
TRICHOCERCA LONGISETA	0	0	0	0	0	0
DAPHNIA PARVULA	225	0	0	0	0	0
NOTHOLCA SQUAMULA	0	0	0	0	0	0
LEDADELLA SPP	0	0	0	0	0	0
totals	150075	100	131380	100	124200	100

Appendix 5
Zooplankton Atikokan GS Preoperational Study 1982

Species Name	AKMN	%	AKMS	%	AKSL	%
	N= 1		N= 1		N= 1	
KERATELLA COCHLEARIS	29190	32	14055	26	38700	21
POLYARTHRA SPP	15150	17	10975	20	31275	17
BOSMINA LONGIROSTRIS	7230	8	3700	7	34200	18
GASTROPUS SPP	6255	7	5795	11	17775	10
KELLICOTTIA LONGISPINA	2505	3	740	1	13950	8
ASPLANCHNA SPP	5145	6	1975	4	4500	2
CALANOIDA NAUPLIAR STAGES	2780	3	2220	4	6750	4
CYCLOPOIDA NAUPLIAR STAGES	3475	4	2715	5	8325	5
CYCLOPS BICUSPIDATUS THOMASI	3750	4	2715	5	5175	3
DAPHNIA GALEATA MENDOTAE	1805	2	2840	5	6525	4
DIAPTOMUS OREGONENSIS	2780	3	1235	2	4050	2
TROCHOSPHERA	0	0	0	0	0	0
CYCLOPOIDA COPEPODITE STAGES	1670	2	740	1	2475	1
CONOCHILUS UNICORNIS	1530	2	1850	3	1800	1
CEPHALODELLA GIBBBA	0	0	0	0	0	0
DAPHNIA SPP	280	0	245	0	2700	1
DIAPTOMUS MINUTUS	415	0	0	0	1350	1
SYNCHAETA SPP	280	0	245	0	2025	1
MESOCYCLOPS EDAX	695	1	495	1	900	0
CALANOIDA COPEPODITE STAGES	975	1	245	0	675	0
DAPHNIA LONGIREMIS	555	1	0	0	0	0
DAPHNIA RETROCURVA	975	1	865	2	450	0
CONOCHILOIDES DOSSUARIUS	1670	2	0	0	0	0
MEXARTHRA MIRA	0	0	0	0	0	0
DIAPHANOSOMA LEUCHTENBERGIANUM	415	0	0	0	450	0
CERIODAPHNIA LACUSTRIS	280	0	0	0	225	0
FILINIA LONGISETA	0	0	0	0	225	0
TRICHOCERCA PORCELLUS	280	0	245	0	0	0
BOLOPEDIUM GIBBERUM	0	0	245	0	0	0
LECANE SPP	0	0	0	0	0	0
BRACHIONUS SPP	0	0	0	0	0	0
KERATELLA QUADRATA	0	0	0	0	0	0
PLOESOMA TRUNCATUM	0	0	0	0	0	0
LECANE LUNARIS	140	0	245	0	0	0
UNIDENTIFIED ROTIFER	0	0	125	0	225	0
LECANE LUNA	0	0	0	0	0	0
TRICHOCERCA SPP	0	0	0	0	0	0
TRICHOCERCA CYLINDRICA	0	0	0	0	0	0
TRICHOCERCA LONGISETA	0	0	0	0	225	0
DAPHNIA PARVULA	0	0	0	0	0	0
NOTHOLCA SQUAMULA	0	0	0	0	0	0
LEBADELLA SPP	0	0	125	0	0	0
totals	90225	100	54635	100	184950	100

Appendix 5
Zooplankton Atikokan GS Preoperational Study 1982

Species Name	AKSLU N= 1	%	mean	%
KERATELLA COCHLEARIS	30950	61	39399.2857	35
POLYARTHRA SPP	4685	9	17512.8571	16
BOSMINA LONGIROSTRIS	865	2	9367.14286	8
GASTROPUS SPP	2095	4	8160	7
KELLICOTTIA LONGISPINA	2835	6	4629.28572	4
ASPLANCHNA SPP	740	1	4497.85715	4
CALANOIDA NAUPLIAR STAGES	1975	4	4307.14286	4
CYCLOPOIDA NAUPLIAR STAGES	0	0	4066.42857	4
CYCLOPS BICUSPIDATUS THOMASI	2465	5	3236.42857	3
DAPHNIA GALEATA MENDOTAE	615	1	3097.85714	3
DIAPTOMUS OREGONENSIS	2095	4	2801.42857	2
TROCHOSPAREA	125	0	1785.71429	2
CYCLOPOIDA COPEPODITE STAGES	0	0	1340.71429	1
CONOCHILUS UNICORNIS	125	0	1336.42857	1
CEPHALODELLA GIBBBA	0	0	1028.57143	1
DAPHNIA SPP	0	0	782.142857	1
DIAPTOMUS MINUTUS	0	0	766.428572	1
SYNCHAETA SPP	0	0	717.857143	1
MESOCYCLOPS EDAX	370	1	640.714286	1
CALANOIDA COPEPODITE STAGES	245	0	595	1
DAPHNIA LONGIREMIS	0	0	368.571429	0
DAPHNIA RETROCURVA	0	0	327.142857	0
CONOCHILOIDES DOSSUARIUS	0	0	238.571429	0
NEXARTHRA NIRA	0	0	192.857143	0
DIAPHANOSOMA LEUCHTENBERGIANUM	125	0	173.571429	0
CERIODAPHNIA LACUSTRIS	0	0	136.428571	0
FILINIA LONGISETA	125	0	114.285714	0
TRICHOCERCA PORCELLUS	0	0	107.142857	0
NOLOPEDIUM GIBBERUM	245	0	70	0
LECANE SPP	245	0	67.1428572	0
BRACHIONUS SPP	0	0	64.2857143	0
KERATELLA QUADRATA	0	0	64.2857143	0
PLOESOMA TRUNCATUM	0	0	64.2857143	0
LECANE LUNARIS	0	0	55	0
UNIDENTIFIED ROTIFER	0	0	50	0
LECANE LUNA	0	0	32.1428572	0
TRICHOCERCA SPP	0	0	32.1428572	0
TRICHOCERCA CYLINDRICA	0	0	32.1428572	0
TRICHOCERCA LONGISETA	0	0	32.1428572	0
DAPHNIA PARVULA	0	0	32.1428572	0
NOTHOLCA SQUAMULA	125	0	17.8571429	0
LEBADELLA SPP	0	0	17.8571429	0
totals	51050	100	112359.286	100

APPENDIX 6

CATCHES IN TRIPLICATE BEACH SEINES - ATIKOKAN 1982

	Snow Lake	Icy Lake	Abie Lake	Marmion Lake					Moose Lake
				South	Central	North	Anderson Dam	Lower Seine	
MAY									
Golden Shiner	5	0	0	5	0	0	0	0	0
Blacknose Shiner	0	0	1	20	0	0	1	0	0
Spottail Shiner	0	3	0	0	0	0	0	0	0
Mimic Shiner	0	0	0	102	0	0	1	1	0
Yellow Perch	2	0	0	2	0	0	0	0	9
Iowa Darter	2	0	5	11	0	0	0	0	2
Slimy Sculpin	5	0	0	0	0	2	0	1	0
Total	14	3	6	140	0	2	2	2	11
AUGUST									
White Sucker	40	0	0	0	1	2	5	4	0
Golden Shiner	0	0	0	0	0	5	0	0	0
Blacknose Shiner	106	8	0	166	0	156	0	0	0
Spottail Shiner	0	3	5	28	0	0	0	0	0
Mimic Shiner	3	0	0	3	0	66	41	0	0
Pumpkinseed	352	6	0	0	0	0	1	0	0
Yellow Perch	0	0	8	2	0	6	2	201	0
Iowa Darter	104	4	0	0	0	1	5	0	1
Logperch	0	0	0	0	2	0	22	0	2
Total	605	21	13	199	3	236	76	205	3
OCTOBER									
Northern Pike	0	0	1	0	0	0	0	0	0
Golden Shiner	0	0	1	26	0	0	0	4	0
Blacknose Shiner	2	0	1	99	0	1	0	0	0
Spottail Shiner	0	1	0	0	0	0	0	0	0
Mimic Shiner	0	0	0	75	0	0	0	91	0
Pumpkinseed	2	0	4	2	0	0	0	0	0
Yellow Perch	0	0	1	2	0	0	7	2	0
Iowa Darter	3	2	4	13	0	0	0	12	0
Logperch	0	0	0	0	0	0	3	0	0
Slimy Sculpin	1	0	0	0	0	0	0	1	0
Total	8	3	12	217	0	1	10	110	0

APPENDIX 7

FISH CATCH IN GILL NETS - ATIKOKAN 1982

	Snow Lake		Icy Lake		Able Lake		Slush Lake		Harmion Lake										Moose Lake	
									Lower Seine		South		Central		North		Anderson Dam			
Depth (m)	IS	OS	IS	OS	IS	OS	IS	OS	IS	OS	IS	OS	IS	OS	IS	OS	IS	OS	IS	OS
MAY																				
Lake Whitefish					1	1			1		1	3	1				3	3	3	
Cisco		5	1	3	1	1									1	3	1			
Northern Pike		1	2	4	2	1	3					1		1	2		8		1	
White Sucker	1		11											2	1		9	4		
Yellow Perch			4						1		5							1		
Walleye									2		1	2					5	4		
Total	1	6	7	• 7	15	3	3	0	4	0	7	6	1	3	4	3	26	12	4	0
AUGUST																				
Lake Whitefish										2		6								
Cisco			2						2		1	17	1			6		1		
Northern Pike			4								3	2			1		2			1
White Sucker	2	2	4	2	1											1		2	1	
Yellow Perch											4									
Walleye			1										1		1		1			
Total	2	2	11	2	1	0	0	0	2	2	8	25	2	0	2	7	3	3	2	0
OCTOBER																				
Lake Whitefish					2	3			1	3	8	7	4	6						
Cisco			1							2	3	8	8				2			
Northern Pike		2	2	5	3	1	4									1	3	2		
White Sucker	2	8	2	4	2	2	3						4	9	8		2	2	1	
Burbot							1													
Yellow Perch														1				3		
Walleye			6	1					1	1	4	2	1	2	3	1		2		
Total	2	10	11	10	7	6	8	0	2	6	15	17	17	18	11	2	7	9	1	0

IS - Inshore
OS - Offshore